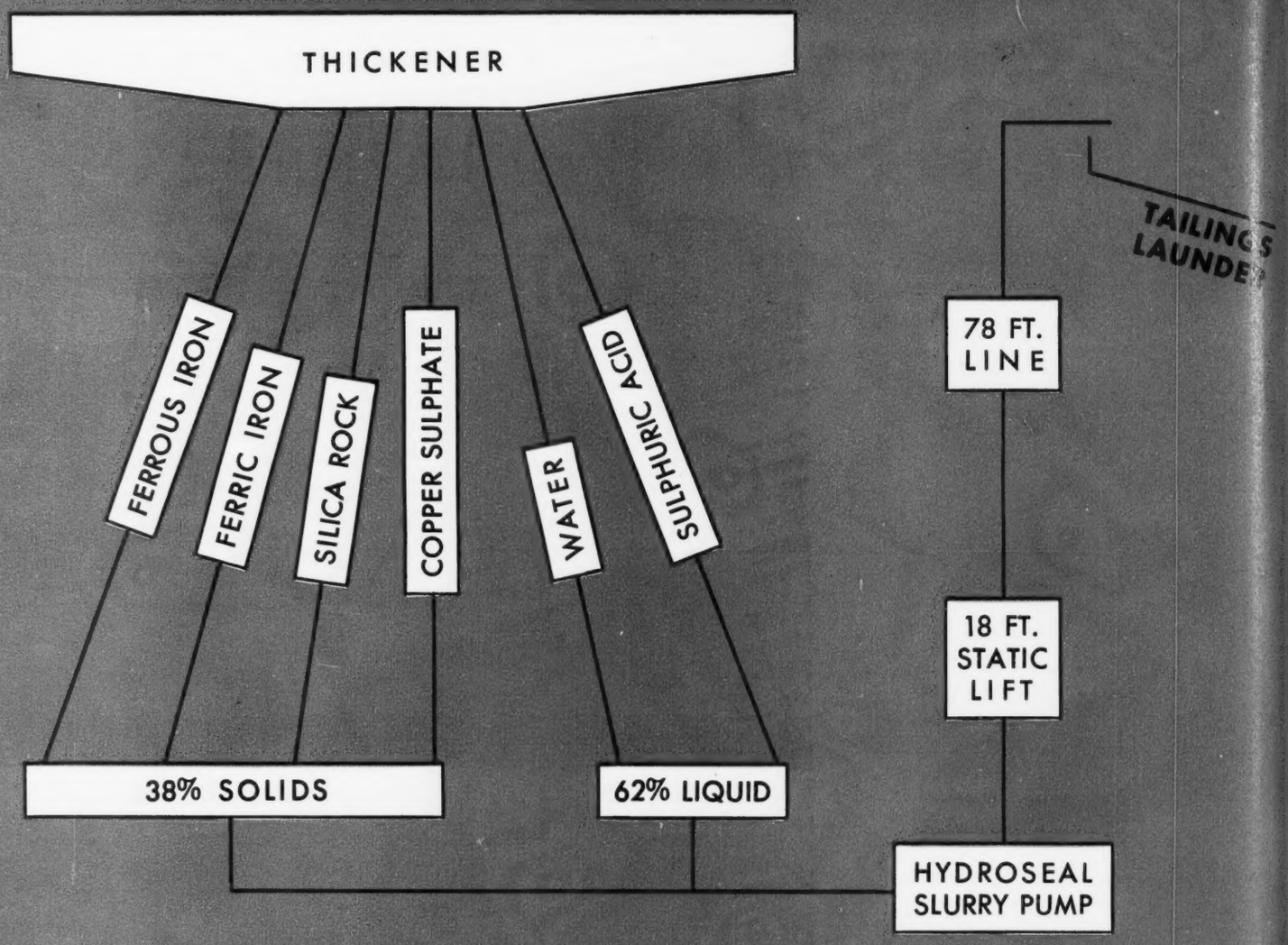
ENGINEERING AND MINING JOURNAL

JUNE, 1940

It lifts, it hauls, it pushes. This diesel tractor, equipped with crane and bulldozer, serves the Pacific Placer Engineering Company, of Valley Springs, Calif., in various ways.

In this issue

Modernization at the Denn Mine
Milling Problems at the Raub Australian Plant
Jigs vs. Riffles in Gold Dredging
Hazards from Static Electricity and Earth Currents
Complete Contents on page 27



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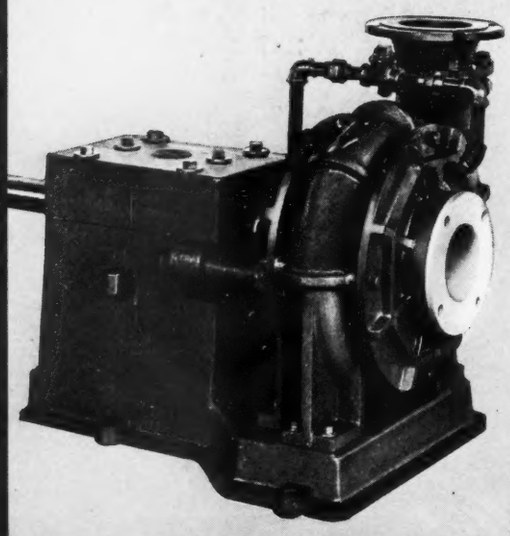

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The divining rod and its derivatives have long been laughed at as instruments for prospecting, despite the prestige their users may have won at times in rural circles in so-called "water-witching." Derision has failed to disturb the diviner's pose. Only recently two exponents of the "art" have bid for recognition (or is it business?) as authors of a book of ambitious size and aspect put out by a British publisher under the title of "The Physics of the Divining Rod." A review of this curiosity by physicists of the United States Geological Survey appears on page 87 of this issue.

▼

Safety as a topic is never trite. When men tire of hearing about it, accidents begin to happen. Safety at Climax is a major consideration. The Molybdenum Company's program is based on the premise that everyone in the chain of command, from the president down to the jigger boss, must believe in and *want* a safe operation. James K. Richardson, Climax's safety director, will discuss his company's policy and its excellent results next month.

▼

Barodynamics, already introduced to *E. & M. J.* readers as a product of Columbia University's mining laboratory that has been applied successfully in practice, needs more clarification, to the end that the average mining man may better appreciate its value for his work. It has for its object the providing of a sound basis for solving the structural problems dealing with the underground, the surface, and the material in between. Next month, P. B. Bucky, originator of the new procedure, will deal with the subject in simple terms, with supporting testimony from a prominent mining company.

▼

Road construction in and to mining areas in Canada received attention from the Dominion's Department of Mines and Resources to the tune of $1,212,940 last year.

H. C. PARMELEE
Editorial Director

ENGINEERING AND MINING JOURNAL

H. W. CLARKE
Vice-President

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Contents for JUNE 1940

Vol. 141, No. 6

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Editorials 31

Some Milling Problems at the Raub Australian Plant 33
E. C. Bitzer and C. B. Nines

Modernization Marks Operations at the Denn Mine 39
John B. Huttl

Jig Versus Riffle Concentration in Gold Dredging 40
Torrence D. Galloway

Electrical Hazards Presented by Static Electricity and Earth Currents .. 42
Paul C. Ziemke

The Gold Deposits of the Paracale-Mambulao District 45
R. D. Gilbert

A Mobile Dry Placer Plant 50
Thomas E. Smith

Interpretation of Sizing Analyses 51
A. O. Gates

The Last Decade in Electrolytic Refining 54

Centrifugal Machine Developed for Dewatering Moisture Samples 56
George E. Tucker

Chalchihuitl 57
E. R. Harrington

Personal Items, Obituaries, Letters 59

Summary of the Markets 62

News of the Industry 65

Book Reviews, Publications Received 87

Equipment News 89

COVER ILLUSTRATION: It lifts, it hauls, it pushes. This diesel-driven caterpillar tractor, equipped with crane and bulldozer, belongs to the Pacific Placer Engineering Company, of Valley Springs, Calif., and serves in various ways. Here it is rebuilding the road through the gravel pit, pay dirt having shown up beneath the original route. The crane is handy when moving camp. Photo by Caterpillar Tractor Company. Cover space released for editorial use by Eimco Corporation.

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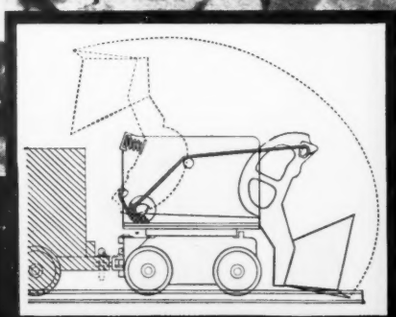

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New York: A. H. HUBBELL, Associate Editor
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For National Defense

TOTAL WAR in Europe was the signal in Washington last month for the most sudden and extensive preparations for national defense that the United States has ever known in time of peace. At the President's request, Congress appropriated billions without asking or knowing how or for what the money was to be spent. The Council of National Defense was hurriedly revived, and an advisory committee was appointed. The President gave a fireside talk in which he made it clear that he would save the New Deal as well as the country. There was no evidence that politics would be adjourned for the duration of the emergency, in spite of the appeal for national unity. Mr. Hoover followed the President with a brief but realistic radio address in which he outlined an organization for industrial production of war material—which probably will not be adopted. The President and Mr. Hoover spoke two different languages.

Admitting the gravity of Old World events, their threat to peace in the Western Hemisphere, and the necessity of providing for our national defense, there is a touch of irony in the domestic situation. The Government finds itself inevitably dependent on business and industry to execute its plans—the same business and industry that the Administration has chastened and harassed for the past few years. Business that was evil because it was too big must now become bigger. Industry that was chided for causing technologic unemployment must now expand its assembly lines or convert them to new production. In short, the very genius and resources of the American people that have been handicapped by the Government must now become its first reliance. Surely the emergency reveals some of the policies of the New Deal as liabilities.

But industry will respond, as it always has. Remembering the Administration's attitude toward profits, it may properly inquire where the money for plant expansion is coming from, and how such risky investment is to be amortized. But given a fair chance, and freed from political meddling, industry will meet any production demands made upon it. Will labor do as much? Or will Messrs. Lewis and Green continue their destructive striving for advantage and power, to the detriment of the national welfare?

We may as well face the fact, born of experience in this and other countries, that the Government can only coordinate the factors necessary to achieve its aims. Of itself it can produce nothing. National defense means, among other things, industrial production; and one of the gravest threats to the successful and economical execution of the nebulous program is political fumbling. The President's advisory committee is only a gesture in the right direction; and unless Mr. Knudsen, Mr. Stettinius, and Mr. Budd are clothed with authority such as they enjoy in their respective industries, they will not be able to produce maximum results. We shall pull through somehow. But one could wish that the Administration was less complacent and had a more realistic appreciation of the country's industrial brains.

Outlook for Mining

EVENTS OF THE PAST MONTH have completely altered the outlook for the domestic mining industry. At the beginning of the war it seemed unlikely that the Allies would have to buy United States non-ferrous metals—certainly not in anything like the quantities purchased twenty-five years ago. There was always the prospect that Allied fabricating plants might be bombed out of existence, but of raw metal, particularly copper and zinc, there seemed to be plenty in British and French possessions. There still is. But the lack of convoyed shipping, due largely to the spread of the war on so many fronts and the more critical demand for other war materials, has cut off the otherwise reliable sources of supply. Add to this the elimination of Belgium's zinc smelters and some of the industrial areas of France, and one sees how radically the situation has changed. Britain has already come into our market for large tonnages of copper and of brass products, and France still has an option on 75,000 tons of copper from United States companies operating in South America, and from Katanga in the Congo.

Our mining industry can readily augment the supply of non-ferrous metals required by the Allies. There is no present or potential shortage. In fact, stocks have been increasing moderately for the past few months, and production could be

quickly expanded. But the problem of ocean transport remains to be solved if the United States adheres to its present neutrality laws. However that condition may be met, the immediate outlook for mining in this country is for increased production of non-ferrous metals, to meet not only the needs of the Allies but also our own program of national defense.

Scramble for Strategics

OUR Washington correspondent reports feverish activity in the nation's capital, reminiscent of World War days. Things that should have been done moderately and quietly several years ago are now the subject of lavish and urgent proposals. Typical is the sudden recognition of the importance of critical and strategic minerals and metals, the purchase of which was authorized in the Strategic Minerals Act.

It will be recalled that this Act provided for the expenditure of $25,000,000 a year for four years to acquire stockpiles of manganese, tungsten, and chromium ores, tin and other mineral products. But initially, when the horizon was clearer than it is today, Congress appropriated only $12,500,000 for the purpose. There seemed to be no hurry about importing foreign ores; and anyhow there was always the secret hope that these things might be found at home.

Now, paradoxically, when skies are cloudier, Congress can see more clearly, and its members vie with one another in generous proposals for mineral stockpiles. Most ambitious is that of Senator Townsend, who offered a joint resolution to appropriate $500,000,000 out of any unexpended amounts in the stabilization fund established by the Gold Reserve Act of 1934. This, together with other proposals receiving serious consideration, brings potential appropriations to nearly a billion dollars. Possibly a tenth of that sum will actually become available, which is what was originally intended. This, however, will be tardy recognition, because we shall be entering the market in a period of rising prices and demoralized shipping that may easily thwart the good intentions of Washington.

Progress in Tin Research

INTERCOMMODITY COMPETITION is an old story. A new product suddenly displaces an old one, with equally good, and sometime better, results. Markets are lost and production declines. No commodity is safe from these encroachments on its established uses. It is an equally old story that vigilant research is the only safeguard against these surprise attacks from unexpected sources.

Apparently this is the philosophy of the International Tin Research and Development Council, which is constantly working to improve and maintain the present industrial uses of tin, as well as to discover and promote new ones. The procedure is worthy of emulation. Through its new laboratories in England and a cooperative arrangement with Battelle Memorial Institute in the United States, the Council initiates research in the uses of tin, and advises consumers on their difficulties and problems. Publications are distributed to a mailing list of about 9,000 names.

In its report for 1939 the Council records investigations in hot-tinning, electro-tinning, electrodeposition of white bronze and other tin alloys, development of new tin-rich bearing metals, and preliminary work on the addition of tin to cast iron. Considering the premier position of the United States as a consumer of tin, the work of the Council is highly important to American industry.

Sayers Confirmed As Mines Director

OVERSHADOWED by momentous world events, the Senate's confirmation on May 27 of Dr. R. R. Sayers as Director of the Bureau of Mines went almost unnoticed in the news of the day. The Senate's action followed by two weeks the President's nomination on May 13, which superseded his appointment of Dr. Sayers as Acting Director.

The post is an important one at any time, but particularly so in the Administration's emergency program of preparedness for national defense. As one of the technical arms of the Government, the Bureau of Mines has a significant part to play in advising the Administration on the country's mineral resources and deficiencies, and in concentrating the ability and energy of its technical and economic staffs on critical problems, the solution of which will contribute to national safety.

Not that the Bureau has been derelict in these duties in the past. On the contrary its voice has been heard repeatedly in favor of mineral preparedness, but the political ear was deaf to counsel and advice based on past experience, knowledge, and information. Now that the foreseen emergency has actually arrived, the Government will probably take a more realistic view of the Bureau's importance in the national economy, and belatedly seek and follow its recommendations. At this critical juncture in the Bureau's affairs we wish for Dr. Sayers a successful and satisfactory administration.

Some Milling Problems at the Raub Australian Plant

A complete procedure has been worked out for treating the carbonaceous gold ore and tailings at this property in the Federated Malay States

E. C. Bitzer[1] and C. B. Nines

Formerly Metallurgist and Assayer, respectively, Raub Australian Gold Mining Company, Ltd., Raub, Pahang, F. M. S.

▶A DESCRIPTION *of the treatment plant of the Raub Australian Gold Mining Company, Ltd., operating in the State of Pahang, Federated Malay States, is presented by the authors. The plant is of interest because three methods of gold recovery are employed in a complex procedure. Furthermore, the ore is of a unique type, and tailings had been accumulating at the property for nearly fifty years before an economical method of treatment was developed.*

A dragline excavator loading dump tailings at Raub

THE mining concession of the Raub Australian Gold Mining Company covers approximately 10 sq.mi. and adjoins the limits of the town of Raub. Most of the surface plant is situated near the village of Bukit Koman, 2 miles from the town. Raub is 80 miles north and east of Kuala Lumpur, the nearest city, which is in the State of Selangor halfway between Singapore and Penang, the latter on the west coast of the Malay Peninsula. The F. M. S. railway has two lines that come within about 40 miles of the mine, but all supplies are brought in by truck from either Kuala Lumpur or Port Swettenham, a port of entry for material from overseas. An excellent paved road connects Raub and Kuala Lumpur. In traveling to the mine it is necessary to cross the first range of mountains of the peninsula's backbone.

Raub is situated in a valley at about 500 ft. above sea level. Despite the low elevation and the latitude, the climate is good. Nights are invariably cool and the country immediately surrounding the mine is free from malaria. This disease is endemic in the region, however, because the low, poorly drained jungle provides numerous breeding spots for mosquitos. The rainy season varies with the direction of the northeast, southwest monsoon and generally runs from the beginning of September to the end of February. Contrary to the commonly held idea, it rarely starts at the same time or is of the same intensity each year. In the vicinity of Raub the rainfall averages about 50 in. per year and is fairly evenly distributed throughout the season. Malaya is out of the typhoon belt and high winds are seldom experienced in this section. Electrical storms are a source of annoyance, however, due to the high humidity, and lightning causes numerous power interruptions.

Mine History—As in most gold-mining districts in the Orient there is ample evidence of the existence of old native workings in the Raub district. The mining was probably done mostly by Chinese, although Siamese and Javanese people have invaded the peninsula at various times in the past. The Malay dislikes most forms of hard work, and it is unlikely that the native inhabitants produced much gold on their own initiative. A familiar legend exists that the gold of Solomon came from this region. The existing concession was granted in 1892, but the earliest available mine record is a report published in 1896, at which time it was estimated that approximately 45,000 tons of ore, assaying more than 1 oz. per ton, had been treated by amalgamation in a steam-driven stamp battery. The tailings evidently were not assayed, but there is reason to believe that recovery was around 75 per cent. This steam plant was operated until 1902.

Four plants, including the present one at Bukit Koman, have operated along the line of reef. A hydroelectric plant, 7 miles from the mine, and 40 head of stamps at Bukit Koman were started in 1900. This was the nucleus of the present 70-head stamp mill. The dump of the old steam plant at Raub Hole and the main dump at Bukit Koman are the only tailings of commercial importance today. The steam plant treated oxidized ore almost exclusively, but the dump

[1] Mr. Bitzer's present address is 1200 12th St., Golden, Colo.

at Bukit Koman contains a mixture of surface-ore tailings and residue of carbonaceous ore that has been mined at depth.

Amalgamation was and is the only major process used for gold recovery. Present-day bullion so recovered is approximately 950 fine with 40 parts silver per 1,000, showing that the gold in the ore is quite pure and amalgamates easily. The bullion in the early days contained slightly more base, but not enough to have offered a problem in recovery by amalgamation. Sporadic attempts were made to cyanide concentrates from the tailings beginning in 1897, but either the early cyanide equipment was inadequate or experienced operators were not available and the treatment was discontinued. Certainly few people could have had much experience with the process at that date, so the first failure is not surprising. As the cyanide process became a common method of gold recovery further attempts were made to use it in conjunction with gravity concentration of the tailings. By 1905, however, mining had reached the zone of carbonaceous ore, which was, and still is, refractory to direct cyanidation.

Today it has been definitely established that the oxidized tailings could have been treated by separating the slime and leaching with cyanide. Treatment of the slime in the early days would have been out of the question for lack of equipment yet to be invented, but a fair recovery could have been obtained from the sandy portion. As early as 1902 roasting was mentioned as a possible method of rendering the concentrates amenable to cyanide treatment, but lack of proper fuel seems to have been an obstacle. During the operation of the steam plant fuel was also a problem because the available jungle wood is of poor steaming quality.

A cyanide plant was actually operated for a number of years beginning in the early twenties, but no operating data were given in reports except production figures on bullion recovered. The work could not have been successful and the plant was eventually dismantled.

Construction of the present tailings treatment plant was begun in 1936 and its operation was started in January, 1937. The procedure employed is the first to be successful, likewise the first in which the tailings have been treated without preliminary concentration.

Labor—Practically all of the labor at the mine is imported, being composed of immigrants, chiefly of Chinese and Southern Indians. The former are mostly Cantonese and Khehs. The Indians are Tamils, Telegus, and Malayalis. Those employed in the stamp battery and tailings plant are mostly Tamils, who perform routine jobs and coolie labor more faithfully than the average. Chinese were used as shift bosses when the tailing plant was put into operation, and they picked up the details of operating and plant control quickly.

The Stamp Battery—From 150 to 170 long tons of ore is crushed daily by the 70 head of stamps. The variation in tonnage cited is due to the mining program that occasionally calls for the extraction of soft upper-level ore from prospecting shafts. Save for this material the ore is a carbonaceous shale with free gold occurring in quartz stringers. Mineralization of the rock is general, however, and the sulphides, most of which is pyrite, are rich in gold. Assays of concentrated sulphides varied from 5 to 7 oz. of gold per ton.

The stamp battery is of the so-called California type; the stamps weigh about 1,000 lb. each and drop 100 times per minute. A jaw crusher serves each group of ten, but the machines are all old, of various sizes, and in varying state of deterioration. Hence there is nothing like an average size of stamp feed. The battery screen in use is 25 mesh and stamp duty on lower-level underground ore averages 2.5 tons per day. Each group of 5 heads discharges over an amalgamating table having an effective area of about 40 sq.ft. and a slope of 1 in. per foot.

The water: solids ratio of the mortar box discharge is about 9 to 1. The specific gravity of the ore is about 2.7.

Gold Recovery—Outside amalgamation is used. Each table consists of three plates separated by trough mercury traps. Generally the plates are dressed twice per 8-hour shift, but this interval is shortened if the ore grade warrants. Ore from each section of the mine is segregated according to origin and clean-ups of amalgam are weighed separately so that the grade of ore going through each battery can be calculated. Thus some batteries at times may be crushing ore much richer than average. Amalgam is removed from the plates every 48 hours, but here again the interval varies with grade of ore. Most of the gold amalgamates on a splash plate laid on the lip of the mortar box and on the upper section of the table. The hard amalgam is scraped up, puddled with mercury, and squeezed by hand on the table. In this condition it averages 37 per cent fine gold. When enough has accumulated from clean-ups it is ground in a clean-up barrel with mercury and lime to free it of sand, sulphides, and tramp metal. The cleaned amalgam is then squeezed by hand through muslin into 50-oz. balls for retorting. The gold content of the clean amalgam is always slightly lower than that of the raw amalgam from the plates.

In some sections of the mine the gold is coarse enough to be retained in the mortar boxes, so that it is necessary to clean these out regularly. The partly crushed ore is removed and concentrated with addition of mercury in a long tom. Mercury and concentrate are subsequently ground in a clean-up barrel to complete the amalgamation. Considerable scrap metal is removed from the mortar boxes, such as old coins and scrap copper from various sources. An appreciable amount of gold is tied up in this material and the skimmings from cleaning the amalgam, and everything is saved until there is enough on hand for a batch for retorting. After retorting the residue is either parted directly with nitric acid or broken up and melted down with stick sulphur to remove most of the base metals. The refined material is added to the sponge obtained from retorting cleaned amalgam, for final melting.

All melting and refining is done in a No. 60 DFC oil-fired crucible furnace. Gold recovered from the stamp battery is melted and cast into bars independently of the bullion recovered from tailing treatment, partly on account of the marketing arrangement and partly to maintain a strict check on tailing plant production. Table I illustrates a typical monthly clean-up from the stamp battery.

Tailing Treatment; Fine Grinding—Amalgamation tailings from currently mined ore discharge into a common launder which delivers the material to an 8x25-ft., duplex Dorr classifier in closed circuit with a 5½x11-ft. Ruwolt overflow-type ball mill. Pulp dilution is high and determines the fineness of grind and, to a large extent, the unit's capacity. Normal daily capacity of the ball mill is 280 tons of current and dump tailings combined when clean, sandy tailings are being mined from the dump. Occasional areas of slimy dump tailings result in daily tonnages as high as 340. Forged-steel balls, 2½ in. in diameter, are used for grinding, consumption varying from 1.5 to 2.0 lb. per ton of tailings.

Tailings from the dump adjoining the stamp battery are mined with a Ruston-Bucyrus dragline excavator, electrically driven. The tailings are loaded into side-dump cars pulled up a ramp to the ball-mill bin. Tailings from the original dump at Raub Hole are delivered to the same bin over the main haulage line from the mine. The sand is discharged from the bottom by a spiral scoop of local design and delivered to the grinding unit by a 14-in. belt conveyor.

Grinding Unit Amalgamation—Recovery of gold from the tailings begins in the grinding unit due to the amalgamation of free gold with

Panorama of the main tailing dump at Bukit Koman. Note channels cut by excavator to drain the dump; also drainage canal at left near completion

mercury that had been lost in previous treatment. All of the free gold in the tailings passes a 200-mesh sieve, but the particles are massive and amalgamate readily. Mercury is added to the ball-mill scoop at the rate of about 0.15 oz. per ton of tailings. Exact consumption is not known, on account of the variable mercury content of the tailings, but the consumption based on the amount added is about 0.10 oz. per ton. A Clark-Todd amalgamator receives the ball-mill discharge together with portion of the pulp coming from the battery. The latter is added to obtain dilution of the amalgamator feed, inasmuch as the addition of water for this purpose would have aggravated a condition already bad. The amalgamator discharge is returned to the classifier by a 4-in. Wilfley sand pump.

About 30 per cent of the gold in the feed of the tailing plant is recovered by secondary amalgamation in the grinding unit. The method of recovery is not ideal, because amalgam has the property of building in the most unlikely and unexpected places and makes loss by theft a serious factor. Another objection is the fact that tie-up of considerable gold is likely to result unless special measures are taken to prevent it. However, there was no alternative to the use of amalgamation at this point, and the metallurgy is sound, as will be seen from the description of the subsequent treatment. It is always best to remove recoverable gold as early as possible in any treatment, to avoid mechanical loss, which can be serious, especially in a flotation circuit where the time of contact is a matter of minutes.

Discovery was made that an appreciable amount of mercury or fine amalgam, probably both, was escaping from the grinding circuit and going to the flotation plant. Laboratory tests showed that both mercury and amalgam floated readily with the reagents in use in the plant and that this was no cause for concern as regards tailing loss. Amalgam was found at various points between the classifier and the flotation plant and also on the rotors of cells in the rougher circuit. From this experience it appears that a secondary amalgamator might be required under some conditions. In fairness to the amalgamator that was installed, however, it should be noted that the tramp amalgam found had accumulated prior to the time it was placed in the circuit. This device will undoubtedly centralize the accumulation of amalgam, because it has ample capacity and dilution of the pulp that passes through it is under control. Pulp dilution is an important factor in the deposition of amalgam.

Gold Distribution in Plant Pulps—Table II gives typical screen analyses and assays showing the distribution of gold in the plant products. The large amount of slime produced by the stamps is of interest when it is considered that the mine-run ore is absolutely free of clay and slime. Presence of free gold is indicated in the gold distribution of the minus-200-mesh sand fractions. All samples for screen analysis were washed free of slime prior to final dry screening, and this accounts for the two minus-200-mesh products in the tabulation. The method of removing the slimes, which consisted in elutriating and decanting from a bucket through a 200-mesh sieve, resulted in concentration of free gold and sulphides in the minus-200-mesh sand fraction of the samples.

Thickening and Flotation—Overflow from the classifier at a water:solids ratio of about 7 to 1 is pumped by a 4-in. Wilfley to a 50x10-ft. Dorr thickener. A portion of the overflow from the tank is returned to the battery for re-use. The pulp generally settles well, and the underflow going to the flotation plant is maintained at about 1.2 to 1, water to solids. Oxidized tailings which contain clay do not settle well and the proportion of this material fed must be limited. When the thickener "slimes," the assay value of the slime in the overflow is practically the same as that in the underflow, which indicates fine division of part of the gold.

The thickened flotation feed is conditioned in a homemade machine which consists of a vertical shaft and impeller mounted in a steel tank. A collector is added to the conditioner and cresylic acid to the rougher circuit in two stages, about 80 per cent to the head cell and the remainder to the sixth cell.

Ten 44-in. Fagergren cells, square type, are used for roughing. Three cells of the same size and type are installed for cleaning. Originally all three cleaner cells were in use, but it was found that most of the value in the rougher concentrate was removed in the first cleaner and the use of the other cells was discontinued to prevent an excessive amount of gangue from going in the final concentrate. This is a point of control in regulating the tonnage of concentrate which must be kept within roasting capacity. The carbonaceous material floats readily but is barren and can be eliminated.

The cleaner tailing is returned to the conditioning tank and the concentrate is pumped to a 10x6-ft. thickener of local construction. A 2-in. Wilfley is used for this work and about 2 lb. of caustic starch per ton of concentrate is added to the pump sump to accelerate settling in the thickener. Use of this reagent produced such a marked improvement in thickening that the proportions of the ingredients and the method of preparation are given herewith.

To 40 lb. of tapioca flour are added 5 gal. of water to form a smooth slurry of starch and this is slowly stirred into 35 gal. of boiling water. The solution is stirred until it is of even consistency and a solution containing 1.2 lb. of caustic soda is then added and stirred in. The starch is then ready for storage and use. The gallon measure is British standard; hence this corresponds to a 10 per cent solution of starch. If the starch slurry is stirred in slowly the solution will be free of lumps and any type of reagent feeder can be used.

Prior to using caustic starch it was necessary to return the thickener overflow to the rougher circuit. Under this arrangement the thickener was acting as a hydro-separator and delivered a

high-grade, thin underflow to filtration. The overflow consisted largely of carbonaceous gangue, but enough gold was present to prevent the material from being sent to waste. The use of starch solved this difficulty because it produced a clear overflow from the thickener that could be wasted. It was also found that the reagent was settling more carbonaceous gangue than the roaster could treat, and it was at this time that the use of two of the cleaner cells was discontinued. The starch had a further effect on roasting and cyanidation that will be described subsequently.

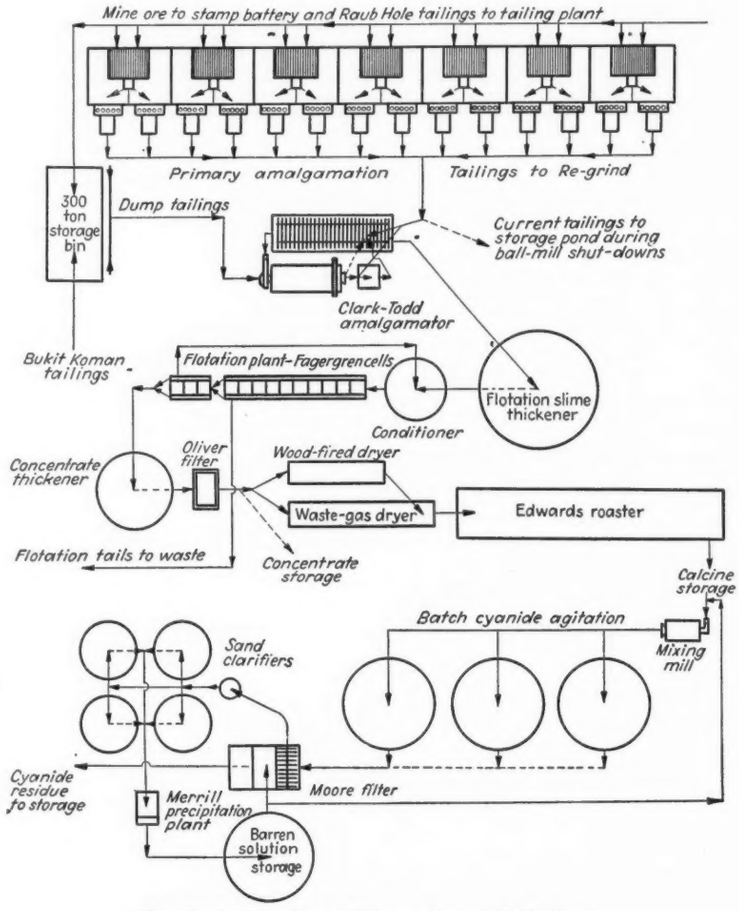
Filtering and Drying—Underflow of the concentrate thickener was filtered on a 5x4-ft. Oliver filter equipped with a barometric sump for disposal of filtrate. The filter operated continuously prior to the use of starch to promote settling. Better thickening obtained by use of the reagent decreased filter operating time to about 60 per cent. The equivalent of No. 175 twill-weave canvas was used on the filter, the life of this cover being four to five months. From 4 to 7 tons of concentrate was filtered daily.

Filtered concentrate was dried by coolie labor on two driers, one using the hot waste gases from the roaster and one heated by wood. The waste-gas drier was constructed of continuous cast-iron plates mounted over dust pockets in the flue leading from the roaster. The concentrate was about 95 per cent minus 200-mesh and was dried to about 12 per cent moisture for roaster feed.

Roasting—The roaster was an Edwards 15-rabble, simplex furnace. General dimensions are given in Table III. The sulphide content of the feed was variable. At times more than enough sulphur was present for a self-roasting operation and at other times auxiliary fuel was necessary to eliminate the sulphur and carbon. A burner for this purpose was furnished with the furnace and was installed to fire below the point of calcine discharge. The firebox was lower than the last rabble and was separated from the furnace proper by a firebrick baffle. This arrangement was never satisfactory except for keeping the furnace warm during shutdowns, and a DFC low-pressure burner was installed at the fifth inspection door from the discharge end. This was effective in maintaining the roast, although lack of a proper firebox caused some spalling of the roof bricks. Roasting temperatures were always lower when this burner was in operation than when the concentrate was self-roasting and the temperature had a decided effect on the subsequent recovery from the calcine by cyanidation.

Effect of Roasting Temperature on Recovery by Cyanidation—No time was available to install thermocouples for measuring roasting temperatures, but the fact that high temperature resulted in a decrease in the recovery by cyanidation was well established. During the first year the sulphide content of the plant feed was relatively high because mining or excavation in the dump was started close to the stamp battery where a concentration of sulphides had taken place. The average recovery by cyanidation for this year was 91.2 per cent, very little fuel being used because the flotation concentrate was mostly self-roasting and high furnace temperatures generally prevailed. In Table IV are listed comparative data on fuel consumption and cyanidation recovery for production periods of 28 days each in the succeeding year. The average recovery by cyanidation for these periods was lower than for the previous year because of a drop in the grade of the calcine; otherwise the comparison of roasting temperature with cyanidation recovery is proper.

The recovery by cyaniding attained in Period 548 (Table IV) illustrates the effect of a low roasting temperature. During this period a low sulphur concentrate was produced, due to the action of the caustic starch in settling all of the gangue in the concentrate thickener, and an unusually large amount of fuel oil was required to maintain roasting temperature in the furnace. Recoveries in cyaniding the calcine increased at once with this change in conditions, but more concentrate was being produced than the roaster could treat. As soon as the available concentrate storage space was filled, a cleaner concentrate was made in the flotation circuit by manipulating the cleaner cells so as to reduce concentrate tonnage, but the calcine from this concentrate did not cyanide as well as the dirtier calcine from the previous practice. The effect on cyanidation is in agreement with roasting research recently conducted in Australia.[1] It was concluded from this research that the porosity of calcine and its permeability to cyanide solutions was a function of roasting temperature; that high temperatures resulted either in a dense calcine or one that was coated with sulphates produced in the furnace.



Flowsheet of the Raub tailings plant at Bukit Koman

There appear to be alternative solutions to the problem of temperature control of this carbonaceous calcine:

1. The production of a high sulphur concentrate by means of gangue de-

[1] "The Condition of Refractory Gold in Lake View and Star (Kalgoorlie) Ore." N. I. Haszard. *Proc.* Aust. Inst. of M. and M. N. S. No. 108, 1937.

pressants in the flotation circuit, followed by direct temperature control of the furnace by means of water-cooled jackets; or by bypassing the gas from the high temperature zone of the furnace; or,

2. To float a very dirty concentrate and increase roaster capacity to handle the tonnage; or,

3. To use gangue depressants in the cleaner circuit in such quantities as to keep the concentrate tonnage within the capacity of the roaster but with enough gangue content to keep roasting temperature low.

Laboratory tests indicated that American Cyanamid reagents Nos. 637 and 645, when used in small amounts, were effective in depressing gangue in the rougher concentrate, but that they depressed gold if used in excess. Therefore it appeared that the third method of temperature control of the roaster was most feasible, and a supply of the reagents was ordered. They did not arrive in time to record plant results here.

Dust Collection—The magnitude of dust loss is unknown but is not an important factor. The dust pockets mentioned account for most of the dust recovered and the greater part of the remainder is trapped in a waste-gas scrubber. This is a wood-lined concrete chamber 7 ft. square, inside dimensions, which receives the gas from the waste-gas drier. It contains a 3-ft. vertical section of wooden grids and is exhausted by a ventilation fan to a 40-ft. stack. Flotation tailings are pumped into the top of the chamber and pass through the grids countercurrent to the flow of hot gas. The tailings contain calcite, and the original purpose of the arrangement was to remove SO_2 from the gases. The efficiency in this respect is doubtful, considering the appearance of trees in the vicinity of the plant, but the grids do seem to form an excellent dust trap. At intervals of about two months they become so badly choked that the draft on the roaster is destroyed and it is necessary to install new grids. The sludge removed from the chamber at this time is returned to the ball-mill bin. The effluent of flotation tailing from the scrubber was check-assayed for a long period and showed no pick-up in value. It is unlikely that no value is carried out here or in the sludge returned to the plant, but obviously the loss is not a serious one.

Cyanidation; Calcine Handling—The calcine is discharged from the furnace by the last rabble and falls on a cast-iron plate. A series of these is set along the furnace foundation, and the hot calcine is moved over the cooling area by hand labor. Dusting at this point is more serious than at any place in the operation, and great care is exercised. When the calcine is sufficiently cool it is sprayed down with water, weighed on platform scales, sampled, and stored for cyanidation. Burnt lime is mixed with the calcine after weighing, at the rate of about 25 lb. per ton. The calcine when damp has a characteristic hematite color, and the loss in weight from concentrate to final product varies from 15 to 20 per cent.

Agitation—Batches of 30,000 lb. of damp calcine, equivalent to about 11 dry tons, are cyanided in three 14x10-ft. agitators. The material is fed by hand to a small ball mill that operates in open circuit and discharges pulp to a 2-in. Wilfley pump for transfer to the agitators. It is doubtful if any grinding takes place in this operation, the function of the mill being that of a mixer only. It is charged with small balls rejected from the main grinding circuit. The calcine is pulped with solution from the barren storage tank and occasionally with fresh water. Due to the peculiar arrangement of the cyanide plant, it is necessary to adjust the stock solution at this point. Burnt lime and Aero Brand cyanide are added to the mixing mill to maintain agitator-solution strength at 2.75 lb. KCN and 0.50 lb. CaO per ton. Solution to solids ratio is maintained at about 3 to 1.

The agitator mechanisms are of local design, consisting of thickener-type rakes operating at 3 r.p.m., with two side air lifts that spray the pulp toward the agitator shaft. Agitation contact varies from 24 to 48 hours, depending on the time required for the subsequent filtering and precipitation operations.

Plant and laboratory tests indicated that the rate of gold dissolution was very rapid for about five hours, after which no further recovery was made. During the first ten months of operation considerable concentration of gold took place in the beds of the agitators and in the accretions around the sides, which illustrates the importance of removing free gold as early in the treatment as possible. Owing to the presence of soluble copper and arsenic, the consumption of chemicals was high and averaged 20 lb. of Aero Brand cyanide and 40 lb. of burnt lime per ton. This is equivalent to about 0.3 and 0.6 lb. per ton of tailings respectively, which would be a low consumption in a direct cyanide treatment.

Filtration—The agitated pulp is filtered directly in a Moore filter equipped with a basket of ten leaves that have an effective filtering area of about 320 sq. ft. The cycle found to give the best results was 10 minute caking and 90 minutes barren solution wash. Construction of the filter did not permit of giving a water wash, and the loss of cyanide was at a maximum. A water wash would have not been desirable, however, on account of the precipitation arrangement, as will be seen. The filter effluent is sent to clarification and precipitation directly and the residue is repulped in water and pumped to a storage dam.

It was found that 70 per cent of the total gold was dissolved in the agitators and that about 20 per cent additional went into solution during the filtration washing cycle. The loss of dissolved gold in the filter cake varied from 0.25 to 0.50 dwt. per ton of solids. This was not excessive, considering the high gold content of the agitator filtrate and the small tonnage of calcine involved. Experiments with double filtration and a period of agitation between filtering indicated that the secondary solution of gold was practically complete with single filtration. The phenomenon of secondary dissolution is common to most cyanide pulps, but the amount in this case was excessive and constitutes a poor operating condition. Had a secondary or washing thickener been installed originally, operating routine,

Table I—Typical Monthly Clean-up, Primary Amalgamation

Item	Oz. Troy
Cleaned amalgam	4,486
Sponge gold recovered	1,687
Mercury recovered	2,789
Retort "loss"	10

Three bars cast, total weight, 1,679.35 oz. Assay of dip sample: 950.85 gold, 39.60 silver.

Source of gold recovered	%
Amalgamating tables	85.5
Amalgam traps	1.5
Discarded battery screens	1.7
Mortar boxes	8.8
Stock mercury	2.5

Table II—Screen Analyses (Tyler Standard Screens)

	Stamp Battery Discharge		Flotation Heads		Flotation Tails	
On mesh	% Wt.	% Au	% Wt.	% Au	% Wt.	% Au
40	3.4	3.6	....	....	....	....
60	10.3	10.2	0.1	....	0.1	....
80	4.9	4.2	0.6	....	0.6	....
100	6.2	3.9	3.6	1.1	2.6	3.4
120	5.6	4.2	8.2	3.6	7.2	3.8
150	3.5	3.1	7.1	2.5	6.1	4.9
200	6.4	4.2	11.7	5.4	11.3	8.9
−200 sands	7.9	13.7	14.1	42.9	15.6	19.8
−200 slime	51.8	52.9	54.6	44.5	56.5	59.2

Table III—Data on Edwards Roaster

Outside dimensions, 70 ft. long by 9 ft. wide.
Rabble radius, 40 in.
Rabble speed, 1.65 r.p.m.
Slope of hearth, 0.33 in. per foot.
Drive, 3-h.p. induction motor.

Table IV—Fuel-Oil Consumption and Recovery by Cyanidation

Period	Oil Consumption, Gal./Ton Calcine	Per Cent Cyanidation Recovery
544	6.4	89.9
545	6.0	88.0
546	11.9	89.2
547	7.9	91.1
548	22.4	94.3
549	6.6	91.4
550	3.0	89.7
551	3.1	90.0

Table V—Sampling Schedule

Sample	Interval	Sampling Period	Remarks
Current amalgamation tailing	30 min	24 hr	Full cut of pulp stream
Dump tailings	Each truck	24 hr	.....
Flotation head	30 min	8 hr	Full cut of pulp stream
Flotation concentrate	30 min	8 hr	Full cut of pulp stream
Flotation tailing	30 min	8 hr	Full cut of pulp stream
Calcine	See text	One batch	.....
Cyanide tailing	One filter cycle	One batch	Cut from leaves in rotation and repulped in strong $KMnO_4$ solution.
Gold solution	Continuous	8 hr	.....
Barren solution	Continuous	8 hr	.....

especially in precipitation, would have been greatly simplified and lower dissolved losses would have been attained.

Clarification and Precipitation—The only source of gold solution is filter effluent, which is pumped from the filter solution receiver to four 6x5 ft. sand clarifiers. The precipitation plant is a standard Merrill installation of 20 bags with a rated daily capacity of 60 tons. Clarification was nearly perfect, but the high copper content of the plant solutions made it necessary to maintain a solution strength of 2.50 lb. KCN per ton to get a suitable barren solution. If the cyanide strength was allowed to fall below this amount, the value of the barren solution would rise and an excessive amount of copper would precipitate in the bags. Dumping of large amounts of barren solution at intervals proved to be of little value in ridding the plant of this metal, because the concentration built up again too rapidly. The solutions seemed to reach equilibrium at about 40 lb. dissolved solids per ton with a copper content of between 1.0 and 2.0 lb. per ton. Use of lead acetate was necessary to maintain consistently good precipitation of gold, although for a time it appeared that the copper content of the solution would be sufficient to furnish the necessary galvanic action.

Consumption of zinc dust was about 0.15 lb. per ton of solution and the amount of lead acetate used was arbitrarily set at one-tenth of this amount. A large bulk of low-grade, granular precipitate was produced and the bags had to be changed every fifteen or twenty days. So much excess zinc was present in the precipitate that the bags would get hot enough to steam if they were allowed to stand more than one hour. The humidity of the atmosphere was usually between 80 and 90 per cent of saturation and some trouble was experienced with feeding zinc dust to the plant until a drier heated by a carbon-filament light bulb was improvised.

Particular care was taken in sampling the Merrill plant solutions and measuring the daily tonnage to keep a close check on gold production. This was especially important at the start of operations before recoveries and a metal balance had been established. Continuous drip samples were taken of the gold and barren solutions by means of a wire cutter arrangement, and the weir overflow crest in the bag tank was kept constant by means of a hook gage and stilling tank that was welded onto the bag compartment. The overflow setting was calibrated against the volume of the barren solution tank periodically. The calibrations always checked to within a few tons per day and the bullion calculation checked actual production closely over a period of a few months. The method used in refining the precipitate resulted in a variable carry-over of gold at each refining, and as a result the month-to-month checks were not very close.

Precipitate Refining—The high base-metal content of the precipitate made it difficult to recover a bullion of good shipping grade. At the start the usual fluxes of borax glass, soda ash, and silica were tried, but, regardless of the proportions used, "wild" slags and low-grade bullion were the result. No oxidizing reagents were used in the straight melting, but attempts were made to roast the precipitate so that the base metals would oxidize and enter the slag. The roasting equipment was not satisfactory, however, and handling the partly sintered, dusty precipitate was objectionable. Finally a flux containing pyrite was developed by repeated trials. This was a modification of the practice at the Lake View and Star mines in Western Australia.

The flux that was finally evolved consisted of 35 parts of borax glass, 15 to 20 parts silica, and 15 to 20 parts pyrite per 100 parts of dry precipitate. The precipitate as it came from the bags gave an indication of the proportion of base metals by its color and final weight, and the pyrite and silica additions were increased or decreased. The raw precipitate was dried to about 30 per cent moisture and fluxed in this condition to minimize dust loss.

Products from melting the fluxed precipitate were a bullion that contained from 600 to 700 parts of gold per 1,000, a matte that contained about 1 oz. of gold per pound, and a slag that assayed from 500 to 800 dwt. of gold per ton. The slag was ground for about twelve hours in a clean-up barrel and returned to the cyanide plant, where it was fed into one of the batches of calcine. The matte was melted with cast-iron turnings which reduced about 96 per cent of its gold content to the form of a low-grade bullion containing about 200 parts of gold per 1,000. This bullion was parted with nitric acid to remove the major part of the base metals. Silver was recovered from the spent acid by precipitation on scrap copper. The secondary matte was crushed for sampling and assaying and, if the gold content was 50 oz. per ton or less, it was stored for shipment to a smelter. The amount of gold tied up in this manner amounted to less than 0.5 per cent of the production by cyanidation.

Occasionally an error in judgment in making the pyrite addition to the precipitate would result in a bullion too low in grade for shipment. In this case the material was granulated and melted with about 5 per cent of its weight of stick sulphur. This treatment was effective in raising the gold fineness. All of the gold produced was sold in Malaya and on account of the limited refining facilities of the buyer, it was necessary to keep the fineness of the cyanide bullion as high as possible The gold recovered by secondary amalgamation in the grinding unit was included with the cyanide gold and the final bullion shipped from tailing treatment averaged around 800 parts gold and 40 parts silver per 1,000. Of the total gold shipped 60 per cent came from cyanidation and the remainder from amalgamation.

(To be concluded)

▼ ▼ ▼

Resoiling of Dredge Tailings

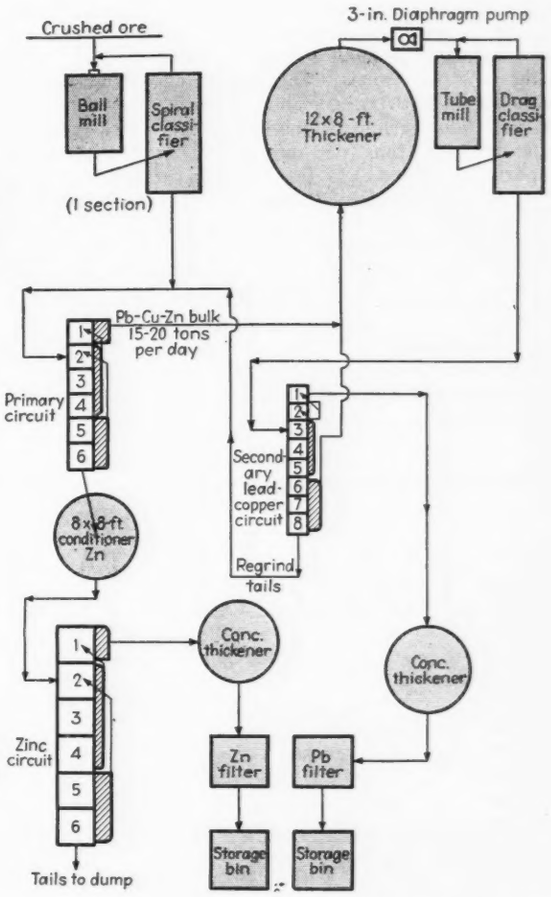
REVIVAL of bucket dredging in Australia has been accompanied by the development of improved methods for the resoiling of dredged areas, according to the March 11, 1940, issue of *Chemical Engineering and Mining Review,* Melbourne. At the deposits being worked by Wellington Alluvials, Ltd., the major portion of the valuable gravel is overlain by barren sandy loam averaging about 36 ft. thick. Dredging practice comprises advance stripping of the overburden, during which operation the entire treatment plant of the dredge is shut down, the only unit in operation, other than the digging equipment, being the overburden conveyor which discharges 210 ft. astern of the pontoon. On completion of the advance stripping, the dredge moves back and extracts the gravel, which then flows through the treatment plant in the usual manner. The tailings are discharged from the stone chute, sand chute, and rock conveyor at points 35, 60, and 90 ft., respectively, astern of the pontoon and evenly distributed over the working width. The procedure results in redepositing the stripped overburden over the tailings behind the dredge as it progresses, the soil bank being leveled off by a bulldozer.

Modernization Marks Operations at the Denn Mine

Shipments of direct-smelting ore and concentrates are steady, with reserves fairly constant. New showings in formerly unproductive ground. Concentrator recently remodeled

Denn mine and concentrator of the Shattuck Denn Mining Corporation, at Lowell, Arizona, in the Bisbee district

John B. Huttl
Assistant Editor



The flowsheet of the remodeled concentrator at the Denn mine. It was developed after lengthy test work

BOTH smelting ore and lead and zinc concentrates are now being produced and shipped to the El Paso smelter of American Smelting & Refining Company by the Shattuck Denn Mining Corporation from its Denn mine at Lowell, Ariz., the second largest producer in the Bisbee mining area. Current output is being maintained on a monthly basis of 10,000 tons of direct-smelting 8 per cent copper ore, and 3,000 tons of lead-zinc-copper ore, of which an appreciable tonnage has been developed during past years, for milling in the remodeled concentrator a short distance from the mine. This unit started operation a few days prior to my visit on Feb. 24. As the company in recent years has spent considerable money for underground improvements such as concreting the main shaft, mechanization of mucking operations, and others, and is now completing the modernization of the surface plant proper to cut costs further and provide better working conditions and safety for its employees, a brief description of what has been done recently should be of interest.

Underground development work has been kept well ahead of exploitation, with the result that total ore reserves have remained fairly constant in recent years. The four-compartment Denn shaft, equipped with a steel headframe and served by a 600-hp. double-drum electric hoist, is now at a depth of 2,700 ft. In 1939, general development work was done both east and west of the shaft on the 2,310, 2,430, 2,565, and 2,680 levels. The work on the last level is new, and on it alone some 2,500 ft. of exploratory work was carried out. Numerous extensions of the main sulphide orebody discovered in 1936 and described in detail by Worthen Bradley (*E.&M.J.*, May, 1937, pp. 227-28) have been found. Opening up of some good showings of ore, on the 2,565 level east of the Campbell fault and along the Dividend fault—territory long considered as unproductive—has aroused interest among Western mining men, as this circumstance indicates possibilities of a longer life for the camp.

Save for some pillars of ore being removed by square-set and slicing, mining methods employed have not changed greatly. In general, stoping is done either by square-set or cut-and-fill methods, depending on the character of the ground. Drilling is done by modern pneumatic drifters, self-rotating stopers, and jackhammers using 1¼-in. round and 1-in. hexagonal steel. Ore broken in the stopes is scraped into the different ore-loading pockets by electric and air-operated slushers, and mucking in drift headings is done by four Eimco mechanical loaders. Blasting in most cases is accomplished by fuse and cap, with

40 per cent gelatine dynamite. From the loading chutes the ore is drawn into 16-cu.ft. end-dump cars, which are hauled in trains to the shaft stations by storage-battery locomotives, subsequently to be hoisted to the surface in three-deck cages. Ventilation is mechanical, there being available in the mine a 100,000-c.f.m. electric-driven blower. In the older drifts a guniting campaign is now in progress as a dust-control measure and to prevent air-slacking. The company also maintains a small diamond-drill unit, and during 1939 a total of 7,000 ft. of holes was drilled.

As insufficient time has elapsed to gather representative metallurgical operating data, and description of the mill work consequently must be confined largely to the flowsheet evolved after long test work. The lead-zinc-copper ore, with appreciable amounts of gold and silver, is mined at the rate of 3,000 tons per month. Mill capacity is about 125 tons per day. The heads assay 5 per cent lead, 15 per cent zinc, 1 per cent copper, 4 oz. silver, and 0.03 oz. gold. Ore stored in the 75-ton hopper-bottomed steel bin near the mine shaft is transported to the concentrator in large side-dump cars, and reduced to $\frac{3}{4}$ in. by a Telsmith jaw crusher. Grinding to about 95 per cent minus-200-mesh is done in two ball mills actuated by a single electric motor through two Hill friction clutches and operated in closed circuit with drag classifiers. Flotation treatment is indicated in the accompanying flowsheet. Classifier overflow at 30 per cent solids is treated in a six-cell primary flotation machine, the bulk concentrates produced by Cell 1 going to a 12x8-ft. thickener to be thickened to from 50 to 60 per cent prior to entering the regrind circuit comprising a tube mill and a drag classifier, and the tails flowing by gravity to an 8x8-ft. conditioner. The regrind classifier product (10 to 15 per cent solids and 90 to 95 per cent 325 mesh) goes to the lead circuit, entering Cell 3 of the eight-cell flotation unit available for this work, with the tails directed to Cell 2 of the primary machine.

The final lead-copper concentrates from the lead circuit successively receive treatment in a thickener and a disk-type filter before being delivered to the storage bin at the foot of the mill. Conditioned pulp goes to a six-cell zinc unit, Cell 2 receiving the flow. Final zinc concentrates are thickened in a thickener similar in design and size to that handling the final lead-copper product, the underflow being further dewatered in a disk-type filter before going to the storage bin. Tailings from the zinc flotation machine flow by gravity via a wooden flume to the dump a short distance below the concentrator. Flotation, conditioning, and thickener equipment are of Denver Equipment make. The lead concentrates are shipped by rail to El Paso, Tex., and the zinc concentrates to Amarillo, also in Texas.

Reagents are added at the following points: At the head of the ball-mill intake, classifier overflow, before and after conditioner, Cell 2 of the zinc machine, regrind mill feed, regrind classifier overflow, and to Cells 1 and 6 of the lead flotation unit. Types of reagents used are Na_2SO_3; $ZnSO_4$; NaCN; Na_2CO_3; CaO; Aerofloat 31-241-208-226; $CuSO_4$; Z-4 and Z-6; Pentasol No. 26; B-23.

New structures completed recently at the mine include a well-equipped machine shop, an engineering office and a warehouse, and removal of compressor equipment from the hoist house to a separate compressor building is now in progress. An electrical repair shop, a blacksmith and drill sharpening shop, a change house, a laboratory and assay office, and carpenter and timber-framing shops complete the surface plant. The general office is at Lowell. J. A. Wilcox is general superintendent, to whom thanks are due for the many courtesies shown me during my recent visit to the property and for the information contained in the aforegoing, and Howard Hendricks directs operations at the concentrator.

Jig Versus Riffle Concentration in Gold Dredging

Attention is directed to the comparative ratios of concentration at the various stages

Torrence D. Galloway
Mining Engineer
Paracale, Camarines Norte
Philippine Islands

THE ADVENT OF JIGS in the past few years as an advancement over the use of riffles when applied to the recovery of gold in placer mining has resulted in the appearance of many articles concerning their application and efficiency. Many worthwhile points have been presented, but there seems one advantage possessed by jigs over riffles which has not been emphasized sufficiently to enable a more direct comparison to be made between them. Individual dredging properties vary considerably in respect to the distribution of values, character of ground, methods of saving gold, and other factors which influence the extraction of gold values from their original position to one whereby the United States Mint will buy a troy ounce for $35.

The discussion following is based on a hypothetical dredge and should not be applied to any particular property, but it might prove interesting to those who have not realized the enormous task presented to a dredge. It must not only move thousands of cubic yards but extract from each cubic yard, quickly and efficiently, enough values to present a profit to its owner.

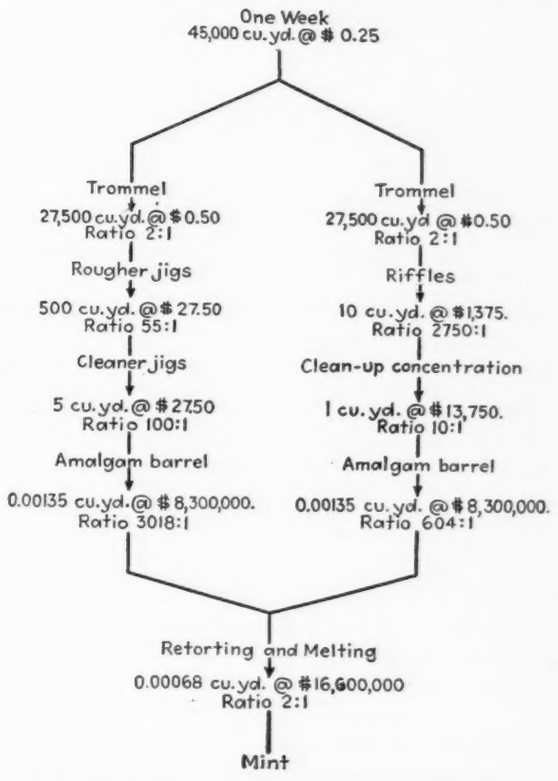
Simply stated, a lode or placer mining enterprise has to concentrate the gold in its property to a form which is salable. The methods vary, but the result is the same. In lode milling practice the term "ratio of concentration" is more common; however, the term should and can be equally well applied to dredging. In placer mining it is customary to mention the volume of material treated rather than the weight. It will be assumed here that the gold has a fineness of 1,000. One cubic yard of gold therefore will

be worth about $16,600,000 (See Lindgren "Mineral Deposits," p. 17, 1933). Again assuming that a property has an average value per cubic yard of 25c., the dredge will have to treat 66,400,000 cu.yd. to obtain the cubic yard of gold worth roughly $16,600,000, and weighing more than 16¼ tons. In other words, a ratio of concentration by volume of 66,400,000: 1 must be accomplished to obtain the finished product whether jigs, riffles, or any other device is used. The losses can be assumed to occur where high concentration ratios are effected. As the values per cubic yard vary above or below 25c., the assumed value, the ratio of concentration is directly affected. For instance, a value of 10c. per cubic yard would give a ratio of 166,000,000: 1.

The values are usually concentrated near bedrock and the upper portions barren, yet the fact that all yardage is treated necessitates the assumption that each cubic yard contains the same value, and all values 100 per cent recovered. To compare concentration ratios it will be assumed that the gold dredge referred to here has 8-cu.ft. buckets and treats 45,000 cu.yd. a week. Also, before the installation of jigs, which were Pan-American placer jigs as roughers and pulsator jigs as cleaners, the dredge had 4,000 sq.ft. of gold tables equipped with Hungarian riffles.

The volumes and ratios shown in the accompanying diagram only approximate what is to be expected in the average property in one week's operation. Inasmuch as the property has gravel with 50 per cent screen undersize, it is seen in the first stage that a two-to-one ratio is given for both methods of recovery. As the percentage of undersize varies, the concentration ratios in the first and fourth stages obviously are affected, but the final ratio remains the same. As the screen undersize decreases, the less the burden is on either flowsheet.

In the second phase, and one of the most important, there is shown the largest diverse comparison. Here, riffles and jigs treat the same amount of material, but where riffles concentrate by weight, the jigs not only do this but classify the material further as to size, which being relatively free of slime, allows for ease of treatment in later stages. In actual practice the riffles retain many gold values in an exposed condition that allows sudden surges of sand or water to rob them of gold, whereas the jigs, once the gold is caught, allow no loss by these methods. In this stage, riffles are attempting to save the heavier constituents of the material washed, such as gold, black sand, and others, but actual dredging practice with its surges of feed does not allow perfect segregation, and consequently the riffles show a smaller percentage of black sand than that obtained from jigs. If black sand is used as an index to determine the efficiency of either device, jigs far surpass riffles.



A comparison of the volumes of material and ratios of concentration at various points in the flowsheet for one week's operation of an hypothetical dredge equipped respectively with jigs and with riffles

Although the third phase still shows a large difference in the ratios of concentration, it should be noticed that the result is only five times as great in jigs as in riffles. Add to this the fact that the 5 cu.yd. obtained from jigs is all black sand and gold, whereas in riffles many of the lighter constituents are also present. Not shown in the diagram, but important, is the fact that with jigs this is a continuous treatment throughout the week, whereas with riffles the dredge must be stopped, and oftentimes too much stress is laid on speed, which at this stage makes the proverb that "haste is waste" a true one.

In the last stage, which shows a difference in ratios between jigs and riffles, the jig flowsheet still has the higher concentration ratio, but it is logical to put the highest concentration in a unit that with present-day practices allows minimum losses. The reduction of amalgam to a gold bar needs no comment here, inasmuch as a 2: 1 ratio is assumed for both concentrating devices. It is shown in the diagram that with riffles the highest ratio comes in an early stage, and under conditions difficult to control; with jigs it comes later on a smaller volume and this smaller volume allows controlled treatment as a batch amalgam barrel or a similar machine.

The preceding remarks have made apparent that the advantages lie with jigs, inasmuch as they reduce the material by stages in a manner that an intelligent operator can adjust without remodeling the dredge. The fact that jigs concentrate the values in a manner that allows the operation involving the highest ratio of concentration to be performed on a relatively small volume of material and under conditions that can be closely controlled has been one of the greatest aids to gold recovery as applied to dredging. It is interesting to note that, if a lode property had ore averaging a recoverable of $15 per ton and a specific gravity of 2.7, it would have a ratio of concentration by volume of about 485,000: 1 compared with the gold dredge ratio of 66,400,000: 1. If weight ratios are compared, then this lode property would have a ratio of 58,000: 1 against the dredge of 66,100,000: 1. (See "Marks Handbook" p. 469, 1924, for weight of 1 cu.ft. of gravel, sand, wet.)

Many factors prohibit a mill flowsheet from being applied to a gold dredge and many methods are available to a mill operator whereby he can obtain his objective economically, yet his problem appears small when compared with that of the placer miner. If placer miners will take the effort to apply the preceding principle to their particular problem, they will be able to use their results as a basis for improvement.

Electrical Hazards Presented by Static Electricity and Earth Currents

With a summary of requirements for shot-firing underground

Paul C. Ziemke
2032 W. Keefe Ave., Milwaukee, Wis.

NOTWITHSTANDING the great progress that has been made in the art of detonating high explosives by electrical methods as compared to the once universally used time-fuse method, we are still confounded by several important problems that present themselves alike to surface and underground users of electric detonators.

Though we as yet are far from knowing everything about electricity, we do know of its dual nature in respect to negative and positive charges and that the peculiar manifestations noted are dependent on the interaction and relation of these two factors. We also have learned that electricity, as we know it, involves a differential movement of negative and positive current flowing along or through a conductor, whereas static electricity involves opposite charges separated and inmovable or "static" with respect to each other. Usually these charges are generated by friction between unlike substances and are neutralized and manifest their presence by the discharge of visible sparks, slight electrical shocks, and the peculiar, rustling, crackling, and rasping noises only too well known to radio users.

Much research, extended over a long period of time, has determined that static electricity may assume different forms, as follows:

1. Voltaic electricity, which is produced by mere contact of dissimilar metals or conductors as developed by Volta and his experimental device known as the Electrophorous, by means of which was demonstrated the fundamental principals that govern the generation of static charges.

2. Magneto electricity, the source of practically all present-day electricity used for power and lighting, the form in which we best know it. This form of electricity is produced by the movement of one or many conductors through a magnetic field, with the resulting current flowing out over suitable conductors and forming

3. Dynamic electricity, that flows through conductors by virtue of the fact that a difference of potential exists as compared between the two sides of the circuit and is commonly known as kinetic electricity. This kinetic energy produces most of its useful work by reversing the process that produced it. Whereas, originally the current was developed by passing conductors through a magnetic field, the reverse takes place at the work-producing end, where the current produces a magnetic field that causes conductors to move.

The varied methods by which static electricity is produced influence the terms used to distinguish the several forms of electricity known, yet the nature of the electricity produced in no way varies or changes the electricity. The terms used to classify static electricity are as follows: static, galvanic, chemical, magneto, frictional, and thermo. These derive their names from the methods used to produce them. It is this group of forms of static electricity that interest present-day research men now striving to cast new light on the annoyance and hazard of static electricity in industry in general and for explosives men in particular.

Contemporary research has developed new information which proves that static electricity is also produced by impact, pressure, cleavage, and induction.

By far the most practical and effective method of neutralizing and rendering static currents harmless is that of effective grounding. The wires or rods used for this purpose must be of ample size and low electrical resistance to facilitate the draining off of static currents to ground. It is hardly necessary to mention that these grounding devices should be of good mechanical construction also, since all too often a broken grounding conductor represents a greater hazard than if none were used at all.

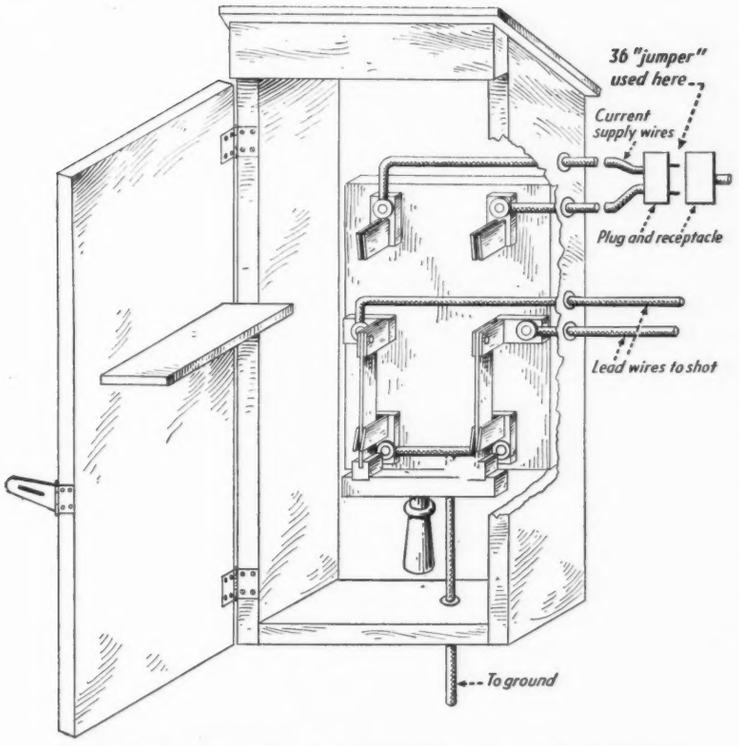
A recommended practice is to install these ground leads in rigid conduit to protect them against injury and to connect them to an independent ground established by burying a lead plate or concentric rings of bare, large-size copper wire laid at a level to insure permanently moist earth. Other connections to water or gas mains or sprinkler systems may prove troublesome, as all too often these prove to be of comparatively high electrical resistance and thus are not electrically neutral. Care must also be exercised in making good electrical and mechanical connections to the equipment to be grounded. Welding or brazing is recommended in preference to bolting or soldering.

Atmospheric Electricity: Lightning—The violent discharges of static electricity earthward from the clouds present the greatest and most destructive hazard to industry. Science has as yet not succeeded in producing an arrestor that is 100 per cent effective. In fact, a great deal of mystery still shrouds this spectacular phenomenon of the atmosphere. The damage suffered by transmission lines and equipment by direct hits and by induced surges involves an enormous expense that must be passed on to the consumer.

Several large electrical-equipment manufacturers have pioneered in the development of laboratory apparatus that closely equals nature in producing lightning bolts. Much progress has been made in perfecting a lightning generator capable of developing direct-current discharges of the staggering total of 3,000,000 volts. It is powerful generators, such as these, that will soon enable scientists to develop effective means of subduing one of nature's most fearsome powers.

Fundamentally, lightning prevention is based on the principle of electrostatics that the highest potentials between two charged bodies are found where pinnacles or sharp projections appear on the surface. It is from these projections that the greatest discharge occurs. If the charges from cloud to cloud are not being increased too rapidly, a lightning arrestor conducts them harmlessly to earth. Where the charges build up too speedily for the arrestor to drain them off, flashovers occur and the bolt is seen to strike the transmission line or lightning rod and is conducted thence to earth. High speed, quick-acting relays incorporated in the modern arrestor assembly prevent all but a negligible amount of line current from following the lightning charge, and the interruption of service is of but split-second duration.

It is when static (lightning) electri-



Blasting switch indicating type of construction required for safeguarding work of preparing an electrical blast

cal discharges are of such violent proportions that they render arrestors inoperative through the magnitude of their volume or strike unprotected power or signal lines and follow these to their extremities that serious and expensive accidents occur in quarries and mines. Scattered and comparatively infrequent as these occurrences may be, nevertheless the hazard must be reckoned with and the necessary steps taken to prevent a recurrence. For it is established that when many or all factors necessary to produce an accident are present, the accident is not long delayed. Several instances noteworthy of mention are recorded here.

In a Witwatersrand mine in South Africa eight native miners were killed outright and four were seriously injured, and two supervising white men escaped destruction only by great good fortune, when a series of blasts were detonated by lightning that struck near the surface buildings and followed a signal line underground.

At a Wisconsin iron mine a heavy bolt struck the ungrounded metal roof of the building housing the hoist engine and proceeded earthward along a roof truss rod, from the lower extremity of which it leaped a 12-ft. gap to enter the earth and the mine through the hoist machinery and cable. The flash and explosion threw the engineer to the floor and rendered him unconscious.

During the driving of the Wachusett-Coldbrook tunnel in Massachusetts lightning struck the blasting line and coursed through its entire length of 411 ft. of shaft run and a mile of main drift wiring, there to fire a prepared blast in spite of the fact that two open safety switches were in the lightning's path.

Many and varied are the occasions where lightning has entered a mine through the medium of telephone and signal services, power lines, rails, pipes, and hoisting cables.

Moreover, tests conducted underground with the aid of milliamperemeters and standard meters and these supplemented by tests with electric squibs present indisputable evidence that current of a volume sufficient to fire an electric detonator may often be present in mine workings although many mines are entirely devoid of ordinary electric power or signal service.

The unearthing of fulgurites in sand and rock strata lends mute evidence of the driving power of a lightning bolt. These long slender tubes of fused glass and other minerals formed by lightning often extend downward for untold numbers of feet, the current being eventually dissipated through the resistance of the material passed through and by splitting off into several channels. Usually these lightning currents follow along the more concentrated or well-defined streaks or veins of mineralization and watercourses. In several isolated instances the enormous momentary amperage expended instantly turned the water to steam, which exerted such expansive powers as to simulate a pronounced explosion.

Current Produced by Thermal, Chemical, and Solar Sources — Some idea may be grasped of the immensity of the earth currents generated by the chemical, galvanic, and thermal properties of the earth when it is stated that the new, and as yet unused, gas main laid to serve the San Francisco World's Fair was discovered to be a total loss due to the deteriorating effect of electrolytic action. The replacement pipe line is protected against destruction by passing a constant stream of direct current through it from end to end. As a rule, currents generated by such means represent no great hazard to blasting operations in quarries or underground where proper precautions are observed, such as maintaining the shunts on the detonator leg wires until the moment they are connected to one another and to the source of blasting power.

Stray or Sneak Currents—A great deal of current is present in open-cut and underground mines by virtue of the fact that the natural currents of nature, as described in the foregoing paragraphs, are greatly augmented by man-made currents seeking low-resistance paths of return to the point of their generation.

One of the immutable laws of electricity decrees that all current generated at any source must return to that source or the current will cease to flow or function. It is this law that forces electrical currents to leave their regular channels when these offer obstacles to the regular and uninterrupted flow of the currents and forces them to seek roundabout and less resistant paths of return to the source of generation.

Electric railways probably offer the most outstanding example of the method of using the rails as the negative and return portion of a power circuit.

The greater cross-sectional area of the rails as compared to that of the single trolley wire and feeder assures an adequate return circuit under ideal conditions where all rail joints are either thoroughly bonded by welding the rail ends themselves, or by shunting around the joints with copper bonds. However, unless the rail return circuit is periodically checked for telltale signs of an increase in ohmic resistance, increasingly large portions of the return current will seek paths of lesser resistance through neighboring earth, water, air, and steam lines as well as the lead or armored sheaths of power and communication cables. It is this bypassed or shunted negative current that represents the greatest hazard, inasmuch as all too frequently the casual conductors just mentioned become charged with a dangerously high potential and thereby may readily serve to detonate explosives prematurely.

In no instance should trolley nega-

tive return circuits be permitted to serve as ground systems for a.c. power or lighting services. Such a.c. services function best with individual ground systems, installed and maintained distinct and separate from the haulage system.

Detection and Elimination of Ground Faults—One of the essential steps in maintaining an a.c. system is the detection of ground faults in a normally ungrounded system. For the undetected grounding of any phase not only represents a serious hazard to life and property but is also the frequent cause of insulation failures in cables and equipment.

Where arcking occurs at the fault, serious burning is usually experienced, which results in rather widespread interference with radio, telephone, and telegraph service. Near-by rails and pipe lines likewise often become charged to exceedingly high potentials and in that condition represent a menace to persons as well as a potential threat to electrical blasting operations.

The detection of these a.c. grounds is effectively accomplished by the installation of protective relays designed to isolate automatically the affected section and to limit the duration of the arcking fault and thus minimize its effects. In addition to tripping a breaker, an alarm is sounded to indicate the condition to the load dispatcher.

As a sequel to the preceding discussion of electrical hazards presented by static electricity and earth currents, Mr. Ziemke summarizes the requirements for shot-firing in mines as follows:

A Summary of Shot-Firing Requirements

WHICHEVER method of connecting shot holes is used, it requires the use of two main circuit conductors which extend from the shot to the source of firing power.

Quite unlike power or lighting lines that may of necessity be maintained in a rather rough and ready manner, blasting lines must be given initial painstaking care in planning their installation and the subsequent maintenance as well. For unless the blast lines are kept free of high-resistance splices and are properly safeguarded from accidental contact with adjoining power or signal circuits, premature blasts or misfires are sure to result.

Open wire construction known as knob and tube work is acceptable for the installation of blasting lines in all cases where the temporary nature of the operation warrants only a minimum of expense in the initial development of the project. Such wiring when thoroughly done by competent wiremen readily lends itself to the peculiar conditions found in mining operations where the movement of the inclosing earth strata and the repairing of timber and pipe lines may be accomplished without entailing too great an expense in the maintenance of the blasting lines.

Wherever conditions permit, the blast circuit should be installed in the tunnel on the side opposite the power and lighting mains, so as to insure the greatest degree of safety from accidental crossing with other lines and the hazard of developing stray current in the blast lines by electrical induction from paralleling power and light circuits.

Where the rock strata consist of stable material that require no timbering, or where conditions are such that the timbering remains permanently placed, a considerable saving of wiremen's expense may be had by substituting duplex wire cable for the open construction of knob and tube wiring. Such a cable is easily installed with a minimum of labor costs and is easily taken down and recovered for removal to other operations. The recommended method of attaching such a rubber-covered duplex cable is by means of the porcelain "tie on" type of knobs or the two-piece porcelain block clamp held in place by two lagscrews.

The live-rubber-covered duplex cable is especially recommended for wet or damp installations where frequently both the air and the water contain acids highly corrosive to copper. The intrusion of this acid through ordinary insulation all too frequently causes the wire diameter to become reduced to the point where the current-carrying capacity is seriously affected or the conductor is severed and an "open" occurs. The acid water also is a good conductor of electricity and thus provides numerous leakage paths from wire to wire or from wire to ground. These grounds seriously dissipate the power intended for the shot and are the direct cause for many mysterious blast failures.

Practically all instruction bulletins on the safe use of explosives issued by explosive manufacturers or government organizations advise against the use of electric current taken from power or light circuits. This advice is timely in that an imposing number of accidents involving explosives have occurred through the careless and slipshod manner in which blasts are connected to a source of power.

I recall an early experience in a tunnel operation where the work of supplying power to the shot was reduced to the simplest terms. The head miner checked the detonator leg-wire connections after tamping operations were completed by connecting one wire of each pair to a common group. Thus two groups or bunches of leg-wire ends were formed to make the familiar "Bohunk" or parallel hook-up. He then connected one group of ends to the haulage rail by means of a short section of No. 12 gage wire. The other group was connected to one end of approximately 300 ft. of No. 12 gage rubber-covered lead wire which he carried rolled in a coil.

As his fellow miners retreated to a safe distance this head miner followed them, uncoiling the wire as he proceeded. When he reached the end of the improvised lead wire he shouted, "Fire!" and made contact with the overhead trolley wire by touching the skinned end of the lead wire to it.

Though the simplicity of the system had much to recommend it, it cannot be accepted as a safe practice, as primarily a serious hazard was developed when the rail was used as the negative side of the blast circuit. Mine and tunnel rails are notorious for possessing dangerously high potentials due to the high resistance offered the return current by numerous bad rail joints.

There is a case on record where this practice of connecting a blast to the rail was used and a premature explosion occurred when a trolley locomotive and train approached the tunnels end over a set of newly laid rails, the joints of which had as yet not been securely bolted. The heavily charged end rails caused current to flow into the blast hook-up, from which it emerged by way of the connection to the 300-ft. coil of lead wire, the exposed end of which rested against an air pipe.

There is no objection to using power or light lines as a source of power supply for the blasting system when such sources are not frequently shut off by the opening of switches or circuit breakers. Rather it is the unsafe practice of using portions of power or light circuits and their switches as lead wires and control switches for blasting purposes that should be abandoned in favor of a blasting system independently constructed and maintained.

However, some necessary precautions must be taken to improve the usual power or light currents, as these, for protective purposes, operate with one phase grounded. This grounded phase, as well as any rail or pipe line used as a conductor, is highly detrimental to successful electrical detonation. It is therefore to be eliminated by inserting a transformer in the blasting system at the point of connection to an a.c. power supply. This transformer, usually of the dry type, with a like number of turns in both primary and secondary winding, ties the blasting circuit to the grounded primary power by inductive coupling and not through direct metallic contact.

This ungrounded output current conveyed over a low-resistance blast circuit kept clear of electrical leaks and free from induced currents created by paralleling power lines makes for ideal blasting, provided, of course, that the

detonator leg wires themselves are also well insulated and offer no leakage paths for the current.

The blasting switch pictured indicates the type of construction required to safeguard the work of preparing an electrical blast adequately. The lead wires are rendered safe during off blasting periods by short-circuiting them through the lower switch blades. In addition thereto any induced or otherwise contacted foreign currents are effectively shunted to ground by means of the heavy ground-wire connection. Further protection is offered against the accidental intrusion of lightning or high-voltage surges by providing a short section of a two-conductor cable equipped with heavy-duty attachment plugs on each end. This 36-in. length of cable is inserted in the gap between the power service outlet and the line side of the blasting switch just prior to blasting time. The baffle located on the inside of the door prevents closing the door in the "up" or firing position, thereby rendering assurance that the entire electrical installation is safely grounded, short-circuited and also disconnected from any power source by a 3 ft. air gap. The "jumper" cable and the key to the switch box lock are retained only by the blaster in charge, thereby centering that responsibility on only one man.

In conclusion it must be mentioned here that all joints made by the interconnecting of the various caps should be thoroughly insulated by wrapping them with tape or by dipping them in either a prepared compound or heated asphalt. And finally as an electrical storm is approaching a surface operation all blast loading operations should cease well in advance of the storm's actual arrival, for no other precaution can prevent a premature explosion by a direct hit.

The Gold Deposits of the Paracale-Mambulao District

A preliminary discussion of the geology of the local ore occurrences. The author crosses swords with those who hold that these are likely to pinch out at shallow depth

R. D. Gilbert
Superintendent, Gumaos Goldfields, Inc.
Paracale, Camarines Norte, P. I.

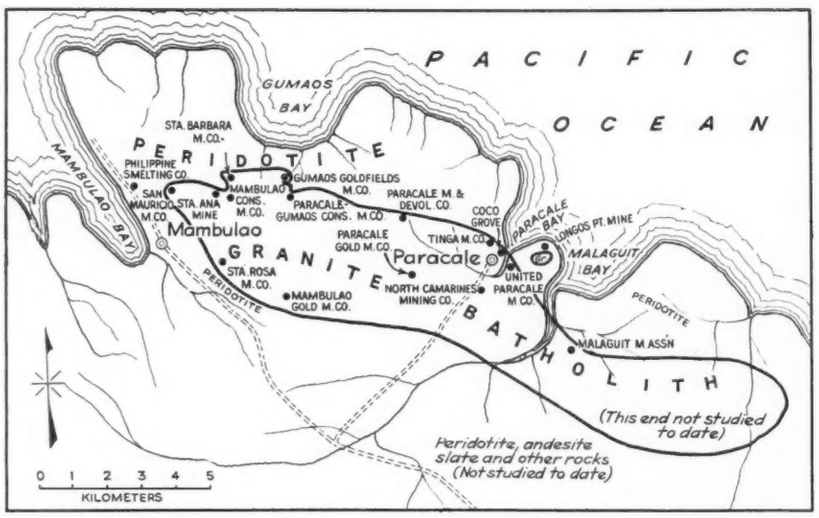
Natives washing gravel for gold near Gumaos

GOLD has been mined in the Paracale-Mambulao district, on the island of Luzon, in the Philippines, for centuries, as evidenced by Ming porcelain and idols found in old diggings. The Chinese, Filipinos, Spaniards, and English who preceded the Americans there failed, however, to penetrate more than about 200 ft. beneath the surface. The average depth of ancient shafts, of which thousands can be found, is less than 100 ft. Most of them were dug for the purpose of getting residual gold from the deep overburden alongside low-grade quartz outcrops. They really represented placer mining, with an occasional divergence into lode mining whenever high-grade quartz shoots appeared in the diggings.

Dredging by Australians in the early part of the present century renewed interest in this district. Modern lode mining began in 1934 and has progressed rapidly, using Philippine, American, and foreign capital and American technical staffs. Several millions of pesos have been wasted on shallow diggings, the purpose of which was to find the orebodies on which the predecessors had mined. But no orebodies of real importance appear to have been left within 100 ft. of the surface unless the ore was too hard to grind in an arrastra. Scratching the surface therefore was usually foredoomed to failure. Several geologists on examining these surface workings reported against deeper exploration. Certain mining companies, however, had the courage to sink, with results so favorable as to justify a description of the gold deposits of the district.

The main geologic feature of the district is a white granite batholith which penetrates a dark-green basic igneous country rock which contains

In the distance is the property of the North Camarines Mining Company (see the accompanying map). In the foreground is the Coco Grove dredging area



The Paracale-Mambulao district is in the Province of Camarines Norte, on the island of Luzon, in the Philippines. This sketch map shows the outline of the granite batholith and the locations of the various mining companies

several ferromagnesian minerals and may be classified as peridotite. Some geologists designate this basic rock as "the metamorphic complex"; others as "schists." Having seen schists, serpentine, and other signs of strong metamorphism only in restricted areas near the granite contact, I prefer to call it "the basic complex" for the time being.

The long axis of this granite intrusive lies approximately parallel to a major northwest tectonic line and probably directly on a strong parallel component of that line. Also, it seems probable that the nearly vertical dip and the northeast strike of all of the important veins indicate the presence of a minor tectonic line along which tension opened fissures widely but failed to produce much width on fissures in other directions. Thus a crossroads, the usual structural requirement for a good mining district, is indicated. Sufficient study of structure has not yet been made. However, the Philippine Bureau of Mines is preparing a report on the resources of the district.

Erosion has exposed the granite batholith over an area of about 50 sq. km. of hilly country of low relief and low elevation, the maximum altitude being about 500 ft. The shape of the granite outcrop is roughly similar to that of a cucumber with the long axis N. 66 deg. W. Near the center is the town of Paracale, which is featured by four producing mines—those of United Paracale, North Camarines, Paracale Mining Development Company, and Coco Grove, the last being a placer. At the northwest end is the town of Mambulao and the San Mauricio mine, which seems destined to become one of the well-known mines of the world. Along the south boundary not far from San Mauricio the Santa Rosa mine is under production, and along the north boundary near San Mauricio the Paracale-Gumaos mine, Santa Ana, Gumaos Goldfields, and Mambulao Consolidated are producing. Many other prospects are scattered along the contact and also outside the granite batholith area. Some of those south of the granite report andesite, slate, and other rocks, but I have not studied them.

Gold quartz deposits occur for the most part in fissures in the granite striking north-northeast, and which were opened by tension just previous to and during ore deposition. Some of these structures extend clear across the granite outcrop, spray out into a broom-shaped group of nearly parallel stringers which cut the contact, and penetrate for a short distance into the basic complex. Others extend to the contact without penetrating the basic complex and bulge out to form large deposits at the contact and extending for a short distance into the granite. Inasmuch as the line of contact bordering the granite intrusive is crooked, with many long tongues of granite extending into the basic complex and conversely many long tongues of the basic complex extending into the granite, fissures cutting across the bases of these tongues afford a number of ore deposits, which, if extending in the line of general weakness—that is, north-northeast—may be of considerable size and value. The main ore deposits of the Paracale Gumaos mine, Gumaos Goldfields, Santa Barbara, Santa Ana, and Mambulao Consolidated are of this kind.

Enrichment of the oxidized zone as at Tonopah, Cripple Creek, and other districts is conspicuously absent. By this I mean that the oxidized portions of the ore do not assay more than the deeper, unoxidized portions. In fact they usually assay less. Also, oxidized ore immediately next to unaltered ore assays less. Outcrops in this district, whether oxidized or not, are almost always low in grade, with better values beneath. This has been attributed to the action of manganese-bearing solutions. But a large number of spectrometric analyses of ore from Gumaos Goldfields and other properties failed to show the presence of this element in the ore. On two veins we have seen a little manganese dioxide coating ore a few feet below the outcrops. This is not at all impressive, considering the evidence of the spectrometric work. I believe that oxidized portions of the vein assay less than unoxidized portions simply because they had much less gold originally. They were composed mainly of pyrite, which I have found by many assays to be typically almost barren. I believe that unaltered hard quartz croppings typically are lower grade than similar material farther down, because the gold was more sluggish and did not ascend as far as the quartz. On the highest hill (altitude 530 ft.) of the Gumaos Goldfields property, several parallel and closely related outcrops have been studied. One cropping at the top consists entirely of sericitized and silici-

fied granite with a marked iron stain. A little lower it has a 1-in. open fissure with comb quartz encrusting one side and resting on a half-inch of finely banded quartz and pyrite. This assays 0.02 oz. gold. On both sides the country rock is highly sericitized and silicified. Lower still in the next vein the fissure and the crystallized quartz no longer appear, but in their place a little vein quartz occurs. Some of this is shot through the altered material at random, and the rest fills narrow stringers. Still the assays do not go above 0.04 oz. Sericitization and silicification is considerably less and coarse pyrite is abundant. Somewhat lower (altitude, 385 ft.) this vein is 20 in. wide and assays 0.38 oz. It is true vein quartz and contains copper minerals and pyrite. Sericitization and silicification have almost disappeared. The vein is tight and the sulphides are unaltered. At the bottom of the hill the first vein described was cut at an altitude of 170 ft. It is a small, tight vein of true vein quartz assaying 0.14 oz. Two hundred feet deeper the diamond drill cut it, giving 0.44 oz. over a 6 ft. width. Other parallel veins exposed at an elevation of 90 ft. are composed of hard, massive, milky quartz with abundant sulphides, including pyrite, magnetite, chalcopyrite, sphalerite, galena, hematite, bornite, covellite, pyrrhotite, and pentlandite. Gold values are spotty but run as high as 6 oz. Recurrent ore surges have introduced some crystalline and some cryptocrystalline quartz that is similar to that found much higher up, but this quartz has no comb structure and does carry good gold values.

Sericitization and silicification are extremely rare. No banding has been seen except within an inch of the wall. One vein cut by diamond drilling at an altitude of minus 30 ft. consisted of 8 ft. of almost pure pyrite assaying 0.04 oz. No pure pyrite veins have been found at the surface. I believe that this demonstrates clearly that the column of ore solution emanating from magma below was very aqueous at the uppermost extremity but that this aqueous vanguard was incapable of carrying much gold nor any of the sulphides except pyrite. Farther down the column the solution was progressively more viscous and contained less and less water, but more sulphides and gold. Subsequent surges were much poorer in water and richer in minerals. These subsequent surges sometimes (if not always) failed to achieve the altitude attained by preceding surges.

Erosion, exposing a vein near its upper limits, will give an outcrop that is poor not because of leaching but because it was made that way. Enrichment by leaching of the pyrite probably occurred but is not detectable in that poor material.

Two distinct types of gold quartz occur in the district—green quartz and white quartz. The green quartz is found only on or near the contact. It is nearly always a foot or more thick and may be 30 or more feet thick (as at Longos Point, United Paracale mine). The bright-green coloration has been attributed by some to chlorite, but analysis by the Guy V. Martin Laboratories, in the United States, has shown that it is caused by a nickel-stained sericite. Sulphides are abundant in this quartz, with uneven distribution. Gold values are spotty, but none of this material is barren.

There are three general modes of occurrence of the green ore:

1. Thin veins usually about 1 ft. thick on the contact.

2. Thick veins mostly in the granite and butting the contact either normally or a few degrees off of normal. If normal, there is also a thin vein extending both ways along the contact. If diagonal, the thin vein extends only one way. The thick deposit extends from the contact into the granite and abruptly pinches down to a narrow high-grade white quartz stringer carrying much galena or sphalerite or both. According to my present knowledge, this type of bulged contact vein does not extend more than about 200 ft. into the granite before pinching.

3. In case one of the north-northeast fractures cuts across a finger of basic complex or a finger of granite, a thick deposit of green ore may be found. If the finger is granite, the vein may be bulged out as it passes through the finger, or if the finger is basic schist, it may be constricted in the finger and bulged out on one or both sides.

In case the finger is granite and quite broad (as at San Mauricio), green ore may be found near the contact and cutting through it with many almost parallel branches. This green ore may change to white ore as it passes strongly through the granite finger without extensive branching.

Green ore, moderately high in grade as mined at Longos, Paracale Gumaos, Gumaos Goldfields, and Santa Ana usually contains galena, sphalerite, chalcopyrite, and pyrite in abundance. Along with these sulphides, considerable amounts of alteration products of the sulphides occur, as well as pseudomorphs of one sulphide after another. It may be said that conditions favoring the deposition of these large bodies of quartz also favored extensive alteration. The green coloration was caused long after ore deposition by oxidation of pentlandite.

White quartz veins occur in the granite, extending in many cases from contact to contact with elaborate systems of branching. The main trunk lines striking north-northeast, however, are the only ones of any real importance. Some of the stringers that strike in other directions may be high-grade in spots.

The white veins, if of sufficient size and grade to mine, are uniformly low-grade ore. That is it is difficult, and sometimes impossible, to maintain mill heads at 20 pesos ($10). Santa Rosa Mining Company and North Camarines Mining Company, however, have sufficient tonnage of this material to make a profit. Their veins are from 2 to 6 or more feet wide. The smaller veins are irregular in width and value, varying usually from 2 in. to 20 in. and from 0.04 oz. to 6 oz. or more. Invariably they are pockety. The white quartz veins often are accompanied by dark greenish-gray, finely granular basic dikes that vary from a few inches to about 6 ft. in width. These dikes do not carry more than 0.06 oz. gold and usually assay only a trace. They are numerous in the granite, run in every direction, and are almost always accompanied by more or less vein quartz or siliceous replacement on one wall or both walls. It is probable that they preceded gold-quartz intrusion by a short interval. The basicity of these dikes and the basicity of the basic complex had a slight influence on metallic sulphide and gold deposition, since a little bit more sulphide and gold is in the veins associated with basic materials than in the veins that are in granite only.

Large dikes, usually 4 to 20 ft. wide, of gray rhyolite occur in several places, cutting both the granite and the basic complex, but their relation, if any, to ore deposition is not now understood. From present data it is known that one of them preceded gold-quartz deposition, and it seems probable that they all preceded it.

Inasmuch as alteration occurs extensively surrounding the green-ore deposits and is negligible around the white-ore deposits, probably the contact was a place of weakness for a considerable time before ore deposition, but the fissures that received the white ore were opened just before ore deposition. We may assume that the first surge of vein quartz filled the contact fissures completely and that a portion of it spread through part of the tight and progressively opening fissures in the granite. Subsequent surges failed to penetrate the contact fissures but did reopen and partly refill the granite fissures as well as filling newly formed fissures in the granite. Completion of the ore surges left the granite fissures sealed and protected from post-mineral alteration agents. But the contact deposits, because of their larger size and their occurrence on an inherently weak structure (the contact), were subjected to intense post-mineral alteration, which changed their color from white to green and made abundant pseudomorphs and other secondary products.

There may have been as many as six surges of quartz into the white veins in the granite, of which four

distinct varieties can be identified easily on sight:

1. Milky-white quartz, hard and shiny with finely disseminated sulphides and pockets of coarse sulphides. Deposited from a viscous solution.

2. Dull, hard, iron-stained cryptocrystalline stringers of not more than about 12-in. width containing finely disseminated sulphides. Deposited from a moderately viscous solution.

3. Similar to No. 2 except that crystallization is pronounced. Small vugs lined with quartz crystals are sometimes found. Banding is fine and regular but is found only within an inch of the wall. On rare occasions very near the surface the terminated crystals of quartz are thickly coated and the vugs filled by a milky-white cherty silica of secondary origin. This third type of quartz was deposited from a moderately aqueous solution.

4. White translucent quartz banded with heavy coarse sulphides, especially galena and sphalerite. The banding is extremely irregular and has none of the characteristics of banding caused by water deposition. Instead, large sulphide crystals are arranged in haphazard, more or less parallel bands that could have been formed by the cooling from the walls inward of a viscous ore solution with considerable vapor tension.

All of these distinct varieties are found in the wider veins, except that occasionally, as in the lower levels of United Paracale, North Camarines, and other properties, wide veins may be completely filled by type No. 4.

Results of spectrometric, microscopic, and chemical analyses made on specimens from Gumaos Goldfields by the Guy V. Martin Laboratories, Albuquerque, New Mexico, are given in Table I.

Inspection of the analyses shown in Table I indicates that the green ore and the white ore are essentially the same in composition but that the green ore is highly altered and the white ore is not. Probably they have the same origin and were injected at the same period, with the green ore occupying altered places on the contact and the white ore occupying tight fissures and closing them so that agents of alteration could not enter subsequently as they did into the green ore.

It is unlikely that the gold-quartz solutions originated with any body of igneous rock that is known to outcrop in the district. Rather it would seem that it originated with a more deeply seated magma that has not been exposed by erosion nor by mining. The peculiar linked structure of the white quartz veins indicates that the underlying magma was an unsolidified portion of the big granite batholith, somewhat more segregated into basic and acidic components than the outcrop and containing residual metallic minerals. Progressive cooling and shrinkage of the granite near the surface caused cracks to form in it and the surrounding basic complex, strong along the northeast line of weakness and weak in other directions. These cracks intermittently were sealed by surges of quartz and sulphides and reopened by further cooling and shrinkage. When the magma cooled and solidified to a depth where further shrinkage could not reopen passages from the magma to the granite, ore deposition in this rock was definitely finished. The following evidence indicates that the gold-quartz solutions ascended more or less vertically along the northeast tectonic line from a mass of magma lying far below on the northwest tectonic line:

1. The white quartz veins fray out into a mass of stringers near the present land surface.

2. Siliceous replacement and sericitization are more common near the surface than at greater depths, where true vein quartz is more common. This indicates greater viscosity with depth as well as explaining the greater strength of the veins and more uniformity in gold distribution.

3. Ore analyses from all of the mines of the district are practically the same. Although there are two distinct types of ore deposits, each with a distinctive color, they are not different in chemical analysis. They are distributed in a northwesterly direction in the granite for at least 20 km.

4. The granite outcrop seems to be only the very peak of an extremely large batholith, most of which still is buried, like an iceberg in the sea. The evidence that supports this assumption is that the contact dips away from the center of the granite outcrop at a flat angle, usually 45 deg. or less.

5. The white quartz veins of the entire district are nearly vertical, and little if any evidence has been found of lateral solution flow.

6. Nearly all of the white quartz veins have been injected repeatedly with quartz and sulphides only. The textures and total gold and sulphides of these various injections vary, but the elements present do not vary.

7. The sulphides found in the veins are not present in either the granite or the basic complex.

8. "Mineralizers," except water, were notably absent. There was even a shortage of sulphur and arsenic. No trace has been found of fluorine, boron, or chlorine. In this respect it is similar to the Mother Lode of California, where I was engaged in 1927.

This theory of origin is contrary to the "epithermal" theory so often heard in the Islands. Various geologists have stated that all of the gold deposits of the Philippines are "epithermal." Few, however, have taken the trouble to offer supporting evidence of any sort. The eight characteristics and the mineralogy of the deposits mentioned in the foregoing make it impossible for me to accept an "epithermal" theory. Clearly this is the result of magmatic differentiation. Only a sudden decrease in pressure such as would be caused by movement along the minor northeast tectonic line will explain why medium- and high-temperature minerals were all precipitated together in this ore. When the movement occurred it opened fissures. Through these fissures surged the water, silica, and metallic sulphides—all of the more volatile magma constituents just as foam surges through the neck of a bottle of beer when the cap is removed. Vapor tension quickly released will explain this ore surgence and deposition without the help of "mineralizers."

The description of these deposits tallies with Lindgren's description of "epithermal" deposits and the descriptions written by other proponents of

Table I—Results of Analyses of Specimens from Gumaos Goldfields

Elements present (in order of abundance):

Silicon, Aluminum, Iron, Magnesium, Zinc, Lead, Copper, Silver, Gold	In all specimens
Cadmium	77% of specimens
Nickel	70% of specimens
Arsenic	54% of specimens
Cobalt	38% of specimens
Calcium	23% of specimens
Sodium	23% of specimens
Vanadium	15% of specimens
Titanium	15% of specimens
Bismuth	8% of specimens
Tungsten (Sta. Rosa)	one mill test sample

Minerals present (in order of abundance):

Quartz, Pyrite, Chalcopyrite, Galena, Sphalerite	In all specimens

In green ore (not always all in same specimen):
Sericite (nickel stained)
Pyrite (pitted; residual rings; oxidized; fractured; a few small fresh grains)
Magnetite
Sphalerite
Galena
Galena replacing pyrite
Chalcopyrite
Chalcopyrite replacing pyrite
Hematite
Pseudomorphs of hematite after pyrite
Pseudomorphs of limonite after pyrite
Pyrrhotite
Covellite
Pentlandite in pyrite
Wulfenite
Cerrusite
Vanadinite
Non-sulphide zinc minerals
Garnet
Silver and gold

In white ore (not always in same specimen):
Quartz (sometimes fractured and healed by pyritiferous quartz)
Pyrite (usualy very fresh)
Magnetite
Chalcopyrite
Galena
Sphalerite
Hematite
Pyrite that can be electroplated by immersion (slightly anisotropic), (observed also in ore from Mapaso Goldfields, Surigao, Island of Mindanao).
Bornite
Pyrrhotite
Covellite
Chalcocite
Sericite
Pentlandite
Garnet
Silver and gold
Capillary cuprite
Native copper

In basic dikes:
Ferromagnesian minerals
Siliceous pseudomorphs after pyrite
Residual hematite
Residual pyrite
Chalcopyrite
Titanium (very small amount)
Gold (occasionally)

the same theory except that the quartz does have a glassy or milky appearance, and three high-temperature minerals, garnet, pyrrhotite, and magnetite, are present. But it is incredible that this ore-depositing solution that effected alteration only in its barren upper extremity contained none of the common "mineralizers," and still deposited both fine and coarse gold in large amounts, could have carried that gold in a dilute aqueous solution at the maximum temperature and pressure postulated by that theory.

All of this is academic, however, except that it affects the interpretation of exposures of the upper extremity of a vein. The valuable ore deposits are the same whether they are called "epithermal" or not. The only disadvantage is that the "epithermal" man is not so likely to find them.

I have little patience with those geologists who state that the gold deposits of this district, the Surigao district, and other Philippine districts, being "epithermal," will soon pinch out with depth and are not worth sinking on. One case is known in which one of them, who had seen ore assaying almost an ounce of gold in a 3-ft. vein all the way down a 100-ft. shaft in the oxidized zone, recommended against sinking on a 5-ft. vein of approximately the same assay value that was exposed near by in the same andesite country rock about 175 ft. higher than the bottom of that shaft. Two reasons were given for this decision:

1. A diamond-drill hole 400 ft. under the 5-ft. vein giving a sludge assay averaging 0.08 oz. over a distance of 107 ft. with no values in the core except 0.14 oz. in two oxidized stretches of about 5 ft. each from which only a few ounces of core were recovered, he interpreted as indicating a mere low-grade stringer!

2. The deposit was "epithermal" and therefore had to pinch out right away.

I do not believe that the late Waldemar Lindgren, whom I respect as an accurate recorder of geological data and who wrote the Philippine geologist's Bible, ever had any intention to disparage what he called "epithermal" deposits, even though he did say that values peter out at a moderate depth.

The figures from his "Mineral Deposits," third edition, 1928, cited in Table II, indicate quite the contrary:

From the figures tabulated, the average vertical extent of deposits Lindgren calls "epithermal" is in excess of 1,500 ft. So those men who, having seen the frayed-out upper fringe and part of the body of these deposits, say that because they are "epithermal" they will soon pinch out, may prove to be false prophets. I believe they have confused the terms "epithermal" and "ephemeral." Recent production figures for this district are far from indicating an ephemeral nature. San Mauricio alone is producing a half million pesos monthly.

All of the mining to date has been in the granite or at the contact. Diamond drilling has only just begun in the basic complex.

Until about eight months ago it was unanimously maintained that the "basic complex" was an incompetent rock. But at that time I began presenting evidence and arguments to the contrary. Recent exposures of ore at Gumaos Goldfields, San Mauricio, and United Paracale definitely have proved that this rock not only is competent but that it contains ore deposits of considerable interest. Near the contact it often is altered to a schist, which may be considered as incompetent and may account for the pinching out of orebodies as they enter it from the granite. However, after having observed dikes of milky-white bull quartz and of white aplitic quartz-albite, both of which carried small gold values (0.04 to 0.14 oz. Au) in the basic complex at a slightly greater distance from the contact, I began more intensive investigation. A geophysical survey at Gumaos Goldfields, the results of which have proved almost 100 per cent correct, indicated heavy mineralization at three places in the basic rock. Surface prospecting in these three places uncovered outcrops of white quartz carrying approximately the same values as other outcrops of the district. They contain small flecks of the typical green sericite coloration as far as 250 ft. away from the contact. Then the flecks disappear and the quartz loses its white color, becoming more transparent. To date these deposits have not been reached by underground operations.

The basic complex has been considered unfavorable to ore deposition because it is basic, is tougher than the granite, and in some places schistose.

Gold ordinarily originates from acidic and intermediate intrusives, but it does not play chemical favorites among country rocks, except that it precipitates more rapidly in the basic ones. It has been found with lead, zinc, and silver in basic shales in the Tecolotes mine, Sta. Barbara, Chihuahua, where I was employed in 1925. Other instances are at El Oro, where gold and silver ore is found in slate, and at Velardeña, Durango, where it is found in diabase; at the Mother Lode, where it is between greenstone and amphybolite schist; and at Victoria, Australia, where it evades hard rocks and forms rich reefs in soft sediments.

In the Paracale-Mambulao district, it is probable that the gold ore did not travel long distances in the basic rock before precipitation took place. According to present data, the maximum penetration is not much over 500 ft.

Small fingers of basic complex at the contact because of their toughness flowed and formed schist instead of fracturing. Larger bodies, however, did not flow. They broke into large blocks. In places where fracturing occurred without any flowing, the fissures should be as good for ore deposition as those in a more brittle rock. Furthermore, it seems likely that they would be larger and not so numerous as in a brittle rock, making fewer stringers and better veins.

Schistosity, being limited in extent,

Coco Grove dredge with the plant of the Paracale Mining Company in the background

Table II—Data on Epithermal Deposits from Lindgren's "Mineral Deposits," 1928

Location	Depth Worked	Total Recovery
Brad, Transylvania	270 meters	.....
Thames, New Zealand	600 ft.	$30,000,000
Karangahake, New Zealand	1,788 ft.	$80,000,000 (to end of 1922)
San Rafael vein, El Oro, Mexico	.....	$40,000,000
Dos Estrellas vein, El Oro, Mexico	1,800 ft. 1913	$ 5,000,000 a year for many years
Black Mountains, Arizona	1,300 ft.	$ 8,000,000 from one shoot
Lamar, Idaho	800 ft.	$ 7,000,000
National vein, northwestern Nevada	800 ft.	$ 3,000,000
Tonopah, Nevada	(About 400 ft.)	$33,500,000 (gold)
Comstock Lode, Nevada	3,000 ft.	$153,000,000 (gold to end 1911)
Pachuca, Mexico	2,000 ft.	.....
Cripple Creek, Colorado	3,000 ft.	$350,000,000 (to end 1927)
Republic, Washington	950 ft.	$ 9,400,000
Radjang-Lebong, Sumatra	.....	50,000 oz. gold
Telluride, Colorado	2,300 ft.	$ 1,000,000 per year
Camp Bird, Silverton	.....	$ 20,000,000 (1903-1916)
Goldfield, Nevada	2,400 ft.	$ 80,700,000 (to end 1917)

(P. 570. "None of the great bonanzas was found below a depth of 2,000 ft.)

can be ruled out for the major part of the basic complex.

Discoveries of ore in the basic complex, such as are being made at present by geophysical surveys, diamond drilling, and surface prospecting, when confirmed by underground operations, may extend the boundaries of this district considerably.

In conclusion, I believe that the Paracale-Mambulao district has the "makings" of a really important gold-mining district of large dimensions. The most valuable deposits are the green-stained quartz bodies at or near the contact. Mining at considerably greater depths than the present 500 ft. or so may reverse this valuation, or mining in the basic complex may reverse it.

This paper is only a preliminary discussion of a district where discussion has been suppressed rather than encouraged. Information and geological opinions are hard to get. It is to be hoped that it will be followed by extensive correction and amplification through the medium of papers by the geologists of other companies in the district. This would throw much light on the district and on Philippine gold mining in general.

I wish to express my gratitude to B. D. Goodier, chief engineer, Botelho, Inc., Manila, for his helpful suggestions, correction of manuscript, and encouragement. Also to various local engineers who from time to time have given information that has helped considerably.

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A Mobile Dry Placer Plant

Thomas E. Smith

IN THE AREA known as Old Placers on the eastern slope of the Ortiz Mountains in Santa Fe County, N. M., the Universal Placer Company is operating a dry plant for recovery of gold from a gravel bed 12 to 20 ft. thick. The location is about 6 miles south of Los Cerrillos on the Santa Fe railway, and 2 miles east of the old village of Dolores. The placer gravels are a portion of an eastward sloping stretch resulting from erosion of the Ortiz Mountains. The field was first discovered in 1828 and is said to be the site of the earliest placer mining west of the Mississippi River. It is reported to have yielded more than $2,000,000 in gold.

The plant of the Universal Placer Company consists of six units:

1. A 180-hp. diesel-electric set generating a.c. current at 440 volts which is transmitted through 600 ft. of rubber-covered cable. This provides power for the motors and solenoid vibrators on the screens.

2. A Caterpillar bulldozer for uprooting small trees and brush and leveling the site for the plant.

3. A 1-cu.yd. Northwest dragline which excavates the gravel and dumps it into the screening plant.

4. The latter rejects all material over ¾ in. which is delivered by belt conveyor to a pit previously worked. Another conveyor carries the undersize to a large hopper, from which it is fed to a squirrel-cage beater that breaks up large dumps of clay. The product is then conveyed and fed slowly to the gold-recovery unit. Here the feed drops onto a mechanically agitated ¼-in. screen vibrating about 1,600 times per minute. The oversize goes to waste and the undersize to a smaller mesh screen vibrated 3,600 times per minute by an a.c. solenoid. An upward blast of air through the screen carries away fine dust and allows the heavier gold particles to remain. These eventually fall through a narrow slot at the lower end of the screen, from which the greater mass of barren material is rejected. The screening of the fine portion is repeated on a final solenoid vibrating screen, from which an enriched gold-bearing concentrate is obtained. The gold particles are 3/32 in. to ¼ in. long, dull yellow in color, flattened, and pitted. They amalgamate readily.

All units of the plant are mounted on trucks, and the outfit can be moved as occasion requires. About 1,000 cu.yd. of gravel is being treated per three-shift day, requiring five men per shift.

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Bureau of Mines Conference

INDICATIVE of the broad range of metallurgical research conducted by the Bureau of Mines is the program presented by the staff of the metallurgical division at a special conference in Salt Lake City, Utah, on May 21, in conjunction with the dedication of the Bureau's new station in that city. The papers presented on that occasion were mimeographed and bound in a limited edition for those attending the conference. They do not represent completed projects, but rather an informal presentation of the types of work carried on in the scattered sections of the division. Metallurgical research is under way at Salt Lake City; Berkeley, Calif.; Boulder City and Reno, Nev.; Rolla, Mo.; Pittsburgh; Tucson, Ariz.; Pullman, Wash.; Minneapolis; College Park, Md.; and Washington, D. C. R. S. Dean, chief engineer of the metallurgical division is located at Salt Lake City. The conference program follows.

Ore Testing, by C. W. Davis.
Electrothermic Magnesium, by H. A. Doerner.
The Smelting of Nickel-Copper Sulphide Ores, by R. G. Knickerbocker.
Progress in the Production of Electrolytic Manganese, by S. M. Shelton.
Manganese Alloys, by R. S. Dean, C. Travis Anderson, E. V. Potter.
Ore Microscopy, by R. E. Head.
Recent Precious Metals Metallurgy, by Edmund S. Leaver.
Electric Furnace Smelting of Domestic Chrome Ores, by R. G. Knickerbocker, M. B. Royer, T. E. Evans.
Beneficiation of Domestic Manganese Ores, by S. M. Shelton.
Development of New Flotation Reagents, by R. S. Dean.
Technical Atmolysis, by Charles G. Maier.
Flocculation of Aerosols by High Frequency Sound, by H. W. St. Clair.
Electrolytic Recovery of Antimony from Antimonial Gold Ores, by J. Koster.
Titanium, by F. S. Wartman.
Properties of Some New Manganese Alloys of Probable Commercial Significance, by C. Travis Anderson.
Lead Smelting as Governed by Products Received, by G. L. Oldright.
Oxidized Lead-Ore Flotation, by S. R. Zimmerley.

Interpretation of Sizing Analyses

The law of size distribution simplifies mathematics of crushing and sizing

A. O. Gates
Salt Lake City, Utah

SIZING TESTS made in the various mills of the mining industry apparently are for the sole purpose of determining details affecting the metallurgical process, especially the maintenance of a predetermined degree of fineness which gives the greatest efficiency in recovery, or the highest return. The sizing test is the only check that can be had on the character of that important mill operation, crushing.

Recently, a number of operators of milling plants were asked about sizing analyses of their crushed ores, and the very general answer was to the effect that about all the screening they did was as a check on size for process and that on but one or two sizes. Some said that they supposed they ought to make such tests, but there were too many other things to do, and some were blunt enough to say, in effect: "What's the use?" A correspondent of the *Engineering and Mining Journal* writes: "I have seen quite a few mills in Mexico and Central America and in nearly all of them the screen tests were conscientiously made on samples but in very few cases were they carried any farther, due to lack of knowledge of the calculations or how to apply them."

I take it that the correspondent referred particularly to calculations based on the screen analyses as affecting the crushing operation, which appears to be the most important reason for "conscientiously" making the screen tests; if we can find mathematics to apply to this operation, we can apply it to some other phases of milling.

Rather complete proof of the correctness of the Rittinger law, that in crushing rock the surface produced was proportional to the energy applied, has been made in recent years. The trouble has been how to apply it. Any application of the law had to take into account the very large amount of very fine material resulting from the crushing operation, or the very large amount of surface; we had no way of directly measuring this surface. All the previous methods were faulty.

The solution of these past difficulties in applying the Rittinger law lies in what must be another law of crushing: the law of size distribution. We know generally that for a given lot of crushed material as the size at which separation takes place decreases, the quantity passing below that size also decreases. A very definite relation exists between these things; it was indicated by me in *Trans.* A.I.M.E., 1915, Vol. LII, pages 899-901, where I said: "to some extent at least, we can approximate the quantity of the finer sizes; there seems to be a law connecting the quantities of different sizes, that the discharge line of a crushing-surface diagram from a uniform crushing operation will be in the form of a hyperbola, and, when plotted on logarithmic paper, as in Fig. 21, will appear as a straight line. . . This, however, is largely speculative, and is only suggested because it may be of some value to some future investigator." No one seemed to have followed the suggestion, and I had to do the following myself, in between other things that had to come first.

The crushing-surface diagram[1] which I had proposed was based upon a very definite physical relation: the area in the diagram below the graph plotted from the screen analysis was directly proportional to the surface exposed on the rock, so far as we had the screen data. We found out that the surface of the unmeasured minus-200-mesh was more important than the measured surface. For a number of years I have been plotting screen analyses as they were obtained, directly or indirectly, on this double logarithmic plot, the necessity for simplifying the technique resulting in the form in which these plots or graphs are presented here. The last two screen analyses that I obtained (one at least honestly) are shown in Fig. 1; they have a characteristic which was predicted before plotting: the lower part of the graph is a straight line, or approximately so.

Right here it is suggested that those who have fairly complete screen analyses available plot those values on this particular form of graph, and draw a straight line through the points of the finer sizes. If the finest size has more than about 75 per cent through, the result may not be satisfactory. There may be a flattening out at the top which may show all the way as a curve. This will be explained later. But if one is lucky and has a screen analysis from a crushing operation in which something of the order of 10 or 15 per cent passes the finest screen, it is fairly safe to predict that the points, starting at the finest sizes, will plot in a straight line, except for the flattening at the top, like the various ones plotted in Figs. 2 and 3. Fig. 2 contains the graphs which are straight for their entire length, and Fig. 3 those which flatten out. One or two exceptions are in each.

It will be noted that these plots or graphs, being from different sources, do not necessarily plot parallel; it thus appears that different ores or rocks have different size distribution characteristics. But if the graphs are from the same source, the same rock, or same orebody or quarry, the chances are that the graphs will be parallel, regardless of the machine in which the crushing has been done. The most striking illustration of this parallelism of graphs of crushed products from one orebody was obtained from a series of articles in this *Journal* (*E. & M. J.*, August, 1936) on the operations of the San Francisco Mines of Mexico. The graphs of the direct crushing operations were all parallel, and where the products were manipulated by screening, etc., they showed the parallelism in parts which could be shown not to have been affected by the manipulation. However, the three parallel graphs in Fig. 1 show the same thing.

Luther Lennox published the results of tests upon ores from a number of mines and gave the relative grindability of each as compared with the ore of the Portland mine, at Cripple Creek, where the tests were conducted.[2] These tests were carefully made under more or less standardized conditions. The results were worked up on the basis of Rittinger's law, as it was then understood, and without complete in-

[1] E.&M.J., Vol. XCV, No. 21, p. 1039 (May 24, 1913).

[2] *Trans.* A.I.M.E., Vol. LXI, 1919, page 237.

sight as to just what the minus-200-mesh consisted of. His data have been plotted by me on these log-log plots, and it becomes evident why his careful work has not been of more value to the profession: very few of them are parallel, and it will be shown later that comparisons are difficult unless the graphs are parallel. Tests from various ores in the same make of ball mill show this same lack of parallelism.

On the other hand the parallelism between products of the same ore but from different machines is not uncommon, but usual apparently, even when there is a time-spread and the ore takes more horsepower-hours per ton in the later sample. From this sort of data it may be proved that the slope of the size distribution graph is an ore or rock characteristic, and that the machine cannot of itself affect the straight portion of the size distribution curve in so far as the slope is concerned.

The slope of the size-distribution graph is assumed by this writer to be the ratio of horizontal to vertical departures (because he used that form in the work of 1915, and because it gives larger numbers to the slopes which are mostly flatter than 45 deg.). On this basis, Lennox's graphs have slopes from less than 1.0 to over 3.0; I have plotted them as steep as 0.75 and as flat as 8.0.

What the crushing machine does in the way of affecting the straight line of the size distribution graph will be found in the upper portion where its failure to break through the coarser particles is responsible for the flattening out of the graph, especially as shown in Fig. 3. Most of the studies of crushing appear to be made upon this flattened portion, which, to my notion, give an entirely erroneous picture of the crushing. These are the particles which are worn down by rubbing, or attrition, and the variable proportions of these particles appears to be responsible for the variation in circulating loads in different milling plants. If our graph is a straight line clear up to the 100 per cent point, it looks as though our reasoning would lead us to a statement that circulating loads are unnecessary in that particular case.

Another case of variation from the straight plot which has puzzled me is particularly shown for rolls in Fig. 3; it has been shown as marked for one other roll product, and in the case of a series of tests which were made with rolls and which were plotted in our form, every graph showed that hump to be present.

There is an explanation for it, although this perhaps is not the place to offer one. Variations or departures from the straight line at the lower portion may be explained by stating that either there was a hole in the fine screen (upward turn) or the screener got tired (downward turn); sometimes moisture may be responsible, or dusting, or something entirely apart from the crushing operation. In a set of analyses of feed and discharge which were plotted in the old crushing-surface diagram some 25 years ago, points on both lines at one particular mesh departed from the smooth curves, and it was felt then, as now, that this was due to a wrong value assigned to that particular screen. If the plot wiggles around, it may be well to check the screens to see that correct values are assigned to them on the graph; for a lot of work an old screen has been good enough. It really is surprising to find so many good screens used when so little importance can be attached to their values up to now. And blessings on the Tyler screen scale!

All this leads up to the power and energy relations, which is what we have been seeking. Let the straight portion of the flattened curves be extended to the 100 per cent through abscissa, and let the mesh at this point be called the mesh-of-grind. Of course, the same thing applies for the graph which is straight for its entire length. As the flattening is due to something besides the breaking through of the particles, something outside the distribution law affecting crushed particles, we can neglect it; the actual surface concerned is negligible. If a line be drawn in the diagram parallel to the straight size distribution line, it will be found that at any mesh ordinate the ratios of the percentages found at these intersections will be constant not only within the visible limits of the diagram, but will be the same no matter how far we extend them into the finer sizes, through the colloid region and out to the unit crystal. From this it may be shown that the exposed surfaces of the crushed material are in that same

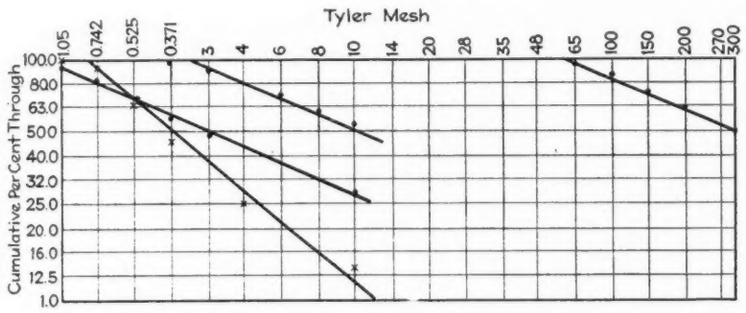


Fig. 1 . . . Size distribution graphs. The data for the three parallel graphs of crushed products were taken at random from the files of a copper company. The steep graph is from data in an Allis-Chalmers advertisement in the *E. & M. J.*, Nov., 1939; the material was gravel; due to its being mixtures of rock of varying qualities, it is hardly to be expected that gravel will show accurately the law of size distribution until crushed much finer

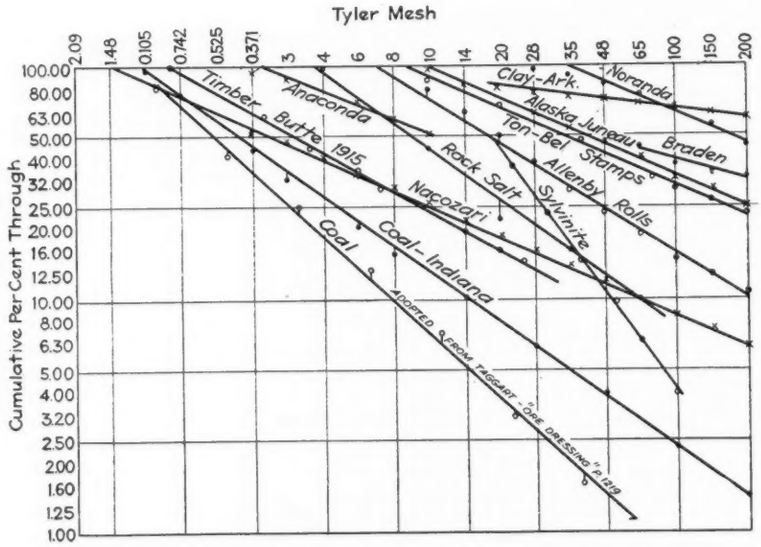


Fig. 2 . . . Size distribution graphs—Straight. These are from the best in the author's collection; others would obscure the picture by plotting in almost identical places. The graph Allenby shows a roll or wave which seems to be quite usual with roll crushing, probably due to spring of the rolls.

ratio, within an error that is infinitisimal except in the rare case that the slope is quite steep.

Energy applied being proportional to surface exposed, and size-distribution graphs being parallel for any given rock or ore, the energy ratio may be found on any ordinate as the ratio of the percentages through at that mesh. This is not a new idea, as mill men have used the quantities of material ground through a given mesh for their comparisons of work accomplished, etc. However, if the graph flattens in the region where these comparisons are made, as for instance 90 and 95 per cent through, the results were only of comparative value.

For a long time it has been suspected that it did not take double the energy to crush a ton to 200 mesh as it took to crush it to 100 mesh; tables of capacities of mills at different mesh-of-grind, made up from experience, indicated as much. To those of us who were advocates, and perhaps worshipers, of the Rittinger theory of crushing, this was a very curious thing. It seemed to upset the whole theory and created doubts. It seemed that it should take double energy to crush from 1 mesh to 201 mesh that it takes to crush from 1 to 101 mesh. Well, it does when the slope of the size-distribution line is 1.0—that is, it slopes at 45 deg. on these diagrams shown, but the mesh-of-grind is dependent upon the slope, and the flatter the slope the greater the increase of mesh-of-grind due to doubling, or increasing, the energy per unit. The mathematical relations, slope being ratio of horizontal to vertical departure and given the value X, are as follows:

$$\left(\frac{HP_1}{HP_2}\right)^x = \left(\frac{E_1}{E_2}\right)^x = \left(\frac{S_1}{S_2}\right)^x = \frac{MoG_1}{MoG_2}$$

HP, horse-power hours per ton

E, Energy in suitable units

S, Surface in suitable units

MoG, Mesh-of-grind, Tyler, theoretical, etc.

As already indicated, the formulas, shown assume that the slope of the graph continues constant out to the size of the unit crystal, or other limit. From some elutriation tests, this slope has been found constant out to about 4,000 mesh. One graph in Fig. 2 is straight to 12,800 mesh. On the bald assumption that "particles below 1,000 millimicrons in diameter will pass through filter paper," a statement regarding colloids, an elutriation straight line was found to line up at 25,000 mesh. So why not expect the size distribution graph to maintain its slope to its limit?

If some of our assumptions are faulty and do not tie in with the facts, at least we have the skeleton of a mathematical theory of crushing. Rittinger's law could be proved by the use of this theory and these formulas, with very little experimental work. It will be up to the industry to apply these formulas to screen analyses, and see if there is not something here that will clear up the fog that exists in the relations between sizing tests and the energy that is expended upon the tonnage.

The graphs themselves tell us something about "slimes." Does one ever hear that a certain ore is slimed because it shows a certain percentage of minus-200-mesh, or that one operation slimes less because it shows less 200 mesh? See what the textbooks say about machines which make more or less slimes, or of one which is or is not a slimer. In making calculations before the simple relationships shown in the formulas were disclosed, surfaces were calculated for various slopes, and it was found that for a slope of 8.0 the surface was something like 10,000 times the surface when the slope was 1.5. Would this tell us anything about the colloidal effects of those two rocks, or rocks with those slopes?

Why one crushed product has one slope and another has a different one is not at all clear. One of the last suspicions is that the simpler minerals have low slope values and that slope values increase as the rock becomes more complex. Hardness seems to have nothing to do with it. One mine after ten years showed an increase of 10 to 20 per cent in power per ton to equivalent mesh, and yet the same slope. The following statement is made with the idea that it may be proved entirely wrong: quartz, pyrite, chalcopyrite, chalcocite, and fluorite show slope values of about 1.0; some of the porphyries have slopes from 2.0 to 3.0; the clay already mentioned has a value of 8.0.

Rocks of apparently the same mineralogical composition from different localities do not have the same slopes apparently. So in clearing up one problem, we only open up a lot more. After all, is it not just what science does—solve something to make more work for the future? Maybe that proves that this is a scientific treatise. And while on the personal, it would be

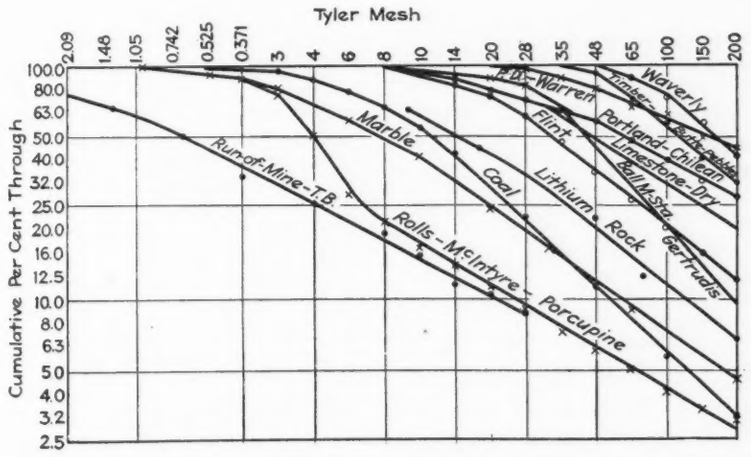


Fig. 3 . . . Size distribution graphs—flattened. Probably two-thirds of sizing analyses plotted are of the above type, flattening at the top; the others available would go into the already crowded portion. The wave in the roll product of McIntyre Porcupine is not unique, as graphs of other roll products often are as marked

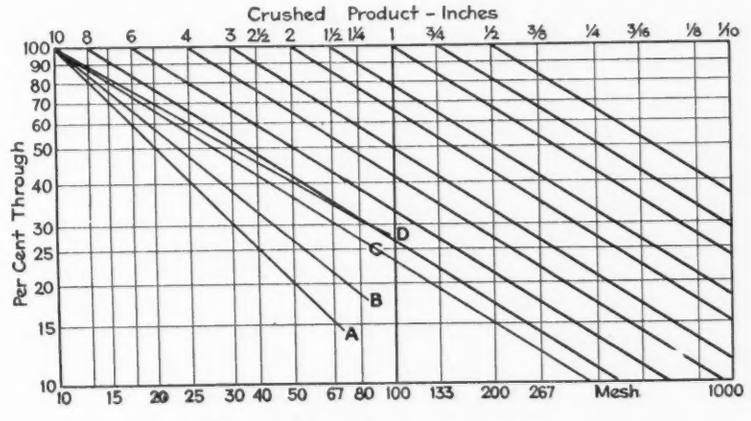


Fig. 4 . . . Theoretical crusher products

interesting to collect sizing data when the mineralogy was included.

If one screen analysis of a rock is available, others may be plotted, as in Fig. 4, which was drawn up in about 1930 for the purpose of determining a variety of crusher products and the quantities which could be expected. Points indicated at *A* and *D* were supposed to be limits, and *B* was limestone and *C* was porphyry. Our information was rather limited. However, this same scheme may be used, drawing at the mesh-of-grind desired the size-distribution line, and there you have it.

The user is warned not to attempt to use two different slope values seemingly obtained upon the same ore. Probably an average slope value will bring fair results. The slight difference between slopes of 2.0 and 2.1 indicates a ratio of 1 to 2 in surface, and it has already been shown that enormous surface difference exist between slopes of 1.5 and 8.0. A slight error in the determination of *X*, the slope, within the limits usually concerned, should not appreciably affect the results.

It is rather pleasing to me that this log-log form of my old crushing-surface diagram should, after a lapse of some 25 years, yield the simple mathematical solution to crushing calculations. At least what is shown here is what was sought at that time.

The Last Decade in Electrolytic Refining

Work on copper and the precious metals has predominated. Much attention given to treatment of anode slimes

A REVIEW of the last decade covering the electrolytic refining of metals was presented by Max W. Heberlein at the meeting of the Electrochemical Society, at Wernersville, Pa., on April 24-27, 1940. It indicates that, throughout the world, development work on copper and the precious metals has been predominating. These metals are economically and commercially more important than others; also, electrolytic methods are the only efficient refining methods for copper and precious metals; whereas fire-refining for other metals is often more economical. In the following some of the more interesting parts of Mr. Heberlein's paper are abstracted:

Despite the depression, the quantity and purity of metals refined electrolytically have increased in the decade.

As to copper, American producers, realizing that world conditions might eventually lead to a serious setback in the market, attempted to control marketing with newly formed organizations and agreements. European groups, however, started to develop large copper deposits on the Continent, and in Africa and Canada.

When the decade started, a relatively large number of refineries had just been completed or were being built, including the Nichols plant in El Paso, Tex., erected solely for economy relative to production and transportation. The same company then built another refinery in Montreal-East to treat Noranda and Flin-Flon blister. Notably, in both cases the multiple system was used for tankhouse design, although the series system was always known to be a special feature of the Nichols Laurel Hill (N.Y.) refinery.

With development of the Frood copper-bearing deposit in the Sudbury district, International Nickel's smelter at Copper Cliff, Ont., was forced to modify its treatment, thereby adding blister to its nickel output. To refine this copper in Canada, the American Metal Company, Ltd., built a new refinery near the smelter and organized the Ontario Refining Company, which started in 1930.

Erection of new refineries and enlargement of existing plants in Europe have been motivated by the "self-sufficiency" policies of European countries. The Boliden development, which had to overcome peculiar difficulties because of the high arsenic of its ore, about 5 parts to 1 of copper with high quantities of selenium, gives Sweden a large copper supply.

In Germany two new refineries were built, one the electrolytic plant of the Zinnwerke Wilhelmsburg, near Hamburg, and the other part of a large-scale modernization plant of the 700-year-old Mansfeld concern. This concern thereupon abolished the old Ziervogel process for recovering silver, thus discarding the last representative of the pre-electrolysis period.

Soviet Russia has built and started new electrolytic plants in Pyschma and Nischnjekyschtym. It asserts that 90 per cent of its total copper output is refined electrolytically.

With development of the African copper deposits, the Belgian interests increased the capacity of the already existing refineries near Antwerp, but made no metallurgical improvements. To eliminate the undesirable impurity, bismuth, Rhokana Corporation had to erect its own electrolytic refinery at Nkana smelter, where it is the first commercial unit of its kind in Africa.

Refineries continued efforts to improve equipment so as to reduce costs. Noteworthy is the increased substitution of concrete tanks for wooden tanks as refining cells, concrete not being subject to warping or distortion. Economy in power consumption is another important factor. Attention has been paid to reducing current losses caused by grounds and resistance in contacts. Designs of busbars, etc., have been changed, contact surfaces enlarged and specially shaped contacts used. Operating methods are being continuously studied to insure maximum economy of power.

Because of increasing quantities of copper-base alloys offered on the scrap market, methods have been suggested and introduced into practice for treating such alloys. For treating such materials as brass, bronze, or monel scrap, United States Patent No. 1,757,047 was granted, whereby the material is cast into anodes and electrolyzed in a Cu_2Cl_2 electrolyte. During electrolysis the electrolyte is circulated through towers packed with the scrap treated, because it is rapidly stripped of its copper in the cell where more copper is deposited at the cathode than dissolved at the anode and part of the current is used to dissolve impurities.

A method developed during the World War in Austria and Germany and published by Weise in 1922 uses a modified $CuSO_4$ refining electrolyte for treating bronze scrap. The electrolyte is circulated over copper scale to re-fortify it with copper. The tin is collected as SnO_2 in the slimes. This is known in this country as the Lewin process and is protected by United States Patents Nos. 1,574,043 and 1,890,856. A. Hollard re-

fines bronzes electrolytically in a modified refining electrolyte of the customary type, but, to maintain proper cell conditions, steam and air are blown into the electrolyte. Antimony may interfere, especially if relatively high. A method suggested by Duckwitz indicates a solution. He apparently refined copper with 8-17 per cent antimony readily.

Electrolytic refining of lead-bearing copper has been simplified by Kühle, who eliminates the dense anode coating of PbO_2 by adding HNO_3 to the electrolyte, which is kept above 50 deg. C.

Copper anodes containing 0.5 to 15.0 per cent of lead plus tin can be refined in an electrolyte of mono- or poly-sulphonates of benzol, phenol, or cresol. According to the United States Patent No. 2,111,575, chloro- or nitro-sulphonic acid may likewise be used. This represents a departure from customary commercial processes. In the past, organic compounds have been avoided for preparing electrolytes, being unstable under electrochemical conditions. (The author thinks the aforesaid patent has only academic value.)

Refining of copper with 20 per cent or more silver has been done by Hänsel. This calls for use of a diaphragm in $CuSO_4$ solution with 5 to 25 per cent free H_2SO_4. Electrolyte temperature of 70 deg. C. and current density of 20 to 25 amp. per square foot are somewhat higher than necessary for refining ordinary blister. When electrolyzing high-gold copper, these anodes often turn passive. W. J. Müller found that gold may be coated with oxide. He suggests periodic rinsing of the anodes in a 5N HCl.

Much attention was given to treatment of anode slimes. The most important publications of the decade relate to recovery of selenium and tellurium. One reason is that with the start of the new plants in Canada and Sweden quantities of the two elements became available, making them no longer rare.

Selenium is the major impurity in the blister at Montreal-East, corresponding to about 0.25 per cent of the blister handled. Resulting anode slimes contain 25 per cent Se, with almost 4 per cent Te, and 45 per cent Cu. The unusual composition calls for unusual treatment. The selenium is volatilized by a sulphating roast in a Herreshoff roaster and, after leaching the calcines with water to eliminate $CuSO_4$, etc., the residue is fused with soda ash to convert tellurium into a water-soluble sodium compound.

Another method for treating high-selenium anode slimes has been developed by the author and consists in a controlled roast at 600 to 700 deg. F. followed by a caustic soda leach to remove selenium. The residue is then leached as usual with H_2SO_4 or spent electrolyte to extract the copper.

At Boliden's Rönnskär refinery (Sweden) an interesting process for treating anode slimes has been developed. This avoids the standard method. The wet slimes are mixed with soda ash and roasted in a multiple-hearth roaster. Calcines are ground wet in a rod mill and transferred to leaching. A water leach extracting the Na_2SeO_4 is followed by a leach with dilute H_2SO_4 to remove copper. The residue is then leached in cast-iron kettles with concentrated H_2SO_4 to remove silver. The last residue is washed and treated with hot NaOH to eliminate $PbSO_4$, leaving pure yellow "gold sand," which, after being melted, is cast into anodes and electrolyzed by the Wohlwill process. Silver is recovered from the H_2SO_4 solution by cementation, and fusion and oxidizing in a small cupel furnace before being cast into anodes. Anode slimes from the silver electrolysis are returned to H_2SO_4 leach kettles.

Other contributions on electrolytic refining of copper have been published which are valuable modifications or improvements of existing methods. These cover the use of the Nichols-Herreshoff furnace for roasting slimes, and elimination of copper by leaching the raw slimes with $FeSO_4$; also the treatment of decopperized slimes with fused caustic soda to eliminate selenium before charging to the doré furnace.

Certain new silver refineries have been influenced by local conditions. If an impure silver has not received a preliminary furnace treatment, the production of high-grade metal by electrolysis may be impossible due to presence of base metals, which, because of their electrochemical properties, have a detrimental effect on the cathode deposit.

Such a condition existed in 1933 in a Dutch parting plant. A treatment plan was developed for producing two grades of fine silver. Refining is done in Moebius cells with a low current density, only 9 to 12 amp. per square foot. Spent electrolyte is treated with NaCl to precipitate silver. Cementation with copper is avoided because selenium would be precipitated with silver. The anode slimes carrying the gold are boiled with HNO_3 and H_2SO_4 to extract the silver, which is precipitated as AgCl. The AgCl precipitates are charged into a special furnace and cast into anodes for the Moebius cells. This second cathode deposit is sufficiently pure for chemical purposes; the first cathode deposit is marketed as "999+fine" silver.

The acid-leached and washed anode slimes (gold sand) are sold to a gold refining plant in Amsterdam, which deserves attention because of successful use of alternating current superimposed onto the direct-current circuit for electrolytic refining of gold, with automatic control. The current is supplied by a d.c. generator in series with two transformers. This proved economical for refining high-silver gold alloys. The current supplied to the Wohlwill cells varies from 280 to 300 amp. d.c. and 300 to 360 amp. a.c., depending on the silver content of the anodes.

Methods of the two silver refineries most recently built in North America adhere to standard treatment except for considering local conditions. Ontario Refining has to consider the high nickel of its copper anodes, but the silver refinery flowsheet is not affected by this. Conditions are different in the Canadian Copper Refiners' silver refinery because the exceptionally high selenium content of the copper anode slimes made the standard treatment impractical.

Another new silver refinery was that of Broken Hill Associated Smelters, at Port Pirie, Australia. Here the silver is parted and refined in Balbach-Thum cells, and the gold is refined by chlorination. About 10 to 15 minutes is required to refine 250 oz. of gold with chlorine gas, yielding a 990 fine product, with 0.08 per cent Pd and 0.02 per cent Pt.

In respect to lead refining, the important advances during the decade are predominantly mechanical in nature. They include changes of design of anodes or new methods of plant operation. They have been incorporated in the new Cerro de Pasco lead refinery in Peru. Here the metal is first detinned in a kettle. The lead, containing up to about 20 per cent of bismuth, besides copper, arsenic, and antimony, is then cast into thin anodes. Noteworthy is the length of anode corrosion period, determined by the total impurity of the anode. Anodes with lead as low as 50 per cent have been successfully refined.

A drawback of the Betts process, unsatisfactory elimination of tin, has been capitalized by United States Metals Refining Company at Carteret, N. J., for producing high-grade solder metal from white-metal scrap. Metal containing 50 to 85 per cent Pb, 48 to 13 per cent Sn, and up to 10 per cent total impurities, is electrolyzed in an electrolyte carrying $SnSiF_6$, $PbSiF_6$, and free fluosilicic acid. Both lead and tin are anodically dissolved and codeposited at the cathode. No attempt is made to control the proportion of lead to tin in the refined alloy deposited. Electrorefined solder of exceptional purity is afterward blended to specifications.

In respect to refining antimony, a process has been developed by the Norddeutsche Affinerie, in Hamburg, where antimony has been refined commercially since 1929. The electrolyte was modified to one consisting of a solution of SbF with 60 to 600 grams per liter free H_2SO_4 and approximately 20 grams per liter free HF. This has been studied by the United States Bureau of Mines.

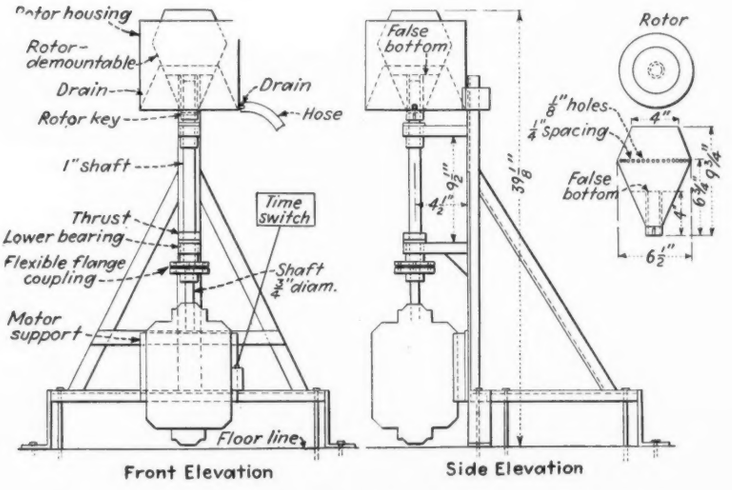
The electrolytic refining of bismuth had already been performed as early as the latter part of last century. Since then a large number of methods have been studied and proposed for plant operation.

Bismuth has been refined more or less successfully with the aid of electrolytes composed principally of nitric, perchloric, fluosilicic, or hydrochloric acids. In the most widely used method the electrolyte contains approximately 100 g./l. of free HCl with 70 to 100 g./l. of bismuth. Electrolysis is carried out at room temperature with a current density of 10 to 20 amp./sq.ft. The potential drop should not exceed 0.15 volt to avoid codeposition of silver and lead. Although an electrolyte of H_2SiF_6 and $Bi_2(SiF_6)_3$ may be of advantage on account of the insolubility of silver, its higher reagent cost makes it uneconomic compared with the HCl electrolyte.

Centrifugal Machine Developed for Dewatering Moisture Samples

An Iron Country innovation, it is proving useful on the Mesabi for removing excess water quickly from 20-car-lot iron ore samples prior to grading

A view of the centrifugal dewatering machine outside the laboratory. The shield or rotor housing, has been removed



Centrifugal dewatering machine for use in laboratory for eliminating excess water in car samples

George E. Tucker
Cleveland-Cliffs Iron Company
Hibbing, Minn.

TODAY the washed iron ores of the Mesabi Range of Minnesota constitute an important percentage of the total shipments of iron ore from the Lake Superior region. The method of securing dependable moisture samples has always been a serious problem, this being as it is the most important factor in grading iron ores in the State.

Two methods have been in use for many years. They are: the moisture box method and the car drainage method. The former involves the use of a so-called moisture box that is constructed with a burlap bottom over which is placed a wire-mesh screen having approximately $\frac{1}{8}$-in. openings. The box containing the wet ore sample is placed where it is protected from the weather and the sample is allowed to drain for about 24 hours. Some difficulty is had in using this method, arising from the length of time required to calculate the moisture for grading purposes and the possibility of contamination.

In the car drainage method railroad cars are allowed to drain a specified time, based on comparative tests over a period of years by Upper and Lower Lake chemists. By this method the calculated moisture can be obtained quickly with satisfactory results. Difficulties are experienced when the time is shortened by the railroad company switching out the loaded cars before drainage is complete and when the ore is subjected to adverse weather conditions during the drainage period.

After considerable study and discussion on this subject, Frank Wassberg, chemist for the Cleveland-Cliffs Iron Company, built a model centrifuge machine that expelled the excess, or free, moisture in 5 to 10 minutes. Finally a standard cone machine was built, detailed drawings of which are shown in the accompanying illustrations.

In the photograph the cone is shown without the shield, which is on the ground at the right. The centrifuge is normally kept in the crusher rooms of the laboratory but has here been photographed outdoors for better light. The top of the cone is 4 in. in diameter, increasing to 7 in. Holes $\frac{1}{8}$ in. in diameter and $\frac{1}{4}$ in. apart are drilled around the periphery of the 7 in. diameter, through which the water is expelled. Experience has shown that there is no loss of ore through these holes. The lower part of the cone tapers from 7 in. to 4 in. in diameter, at which point a solid disk is welded on the inside to act as the bottom of the cone upon which the sample rests.

The cone continues on the same taper to a sleeve that fits over a 1-in. vertical shaft, connected to a $\frac{1}{2}$-hp. electric motor having a speed of 1,725 r.p.m. The motor is controlled by an automatic time switch, allowing the opera-

tor to do other work while the machine is running.

The moisture sample is taken in the usual Lake Superior standard method in 20-car lots, and the sample is crushed to minus ¼ in. After being cut down and divided, approximately 1 kg. is placed in the centrifuge machine. Results of many tests show that practically 95 per cent of the excess water is expelled in one minute, and after two minutes approximately 99 per cent. From this point up to ten minutes very little change is noticeable. Most of the wash ores tested showed that after four minutes practically all the excess water is driven out. A period of seven minutes has been adopted as standard for dewatering ores of Mesaba-Cliffs Mining Company.

The capacity of the cone is approximately 10 lb., but for practical purposes 1 kg. is used. The shield is bolted to the frame. It has a drainage trough around the inside of the lower portion connected to a drainage pipe.

After the excess water is expelled by the centrifuge, a 500-gram portion of the sample is placed in the drying oven and dried at 212 deg. F. for three hours. The moisture is then calculated.

Grading of iron ore in the Lake Superior region becomes more complicated each year because the various elements are now graded more closely to the guarantee than in former years, and it is important that the "iron natural" content be calculated as soon as possible. It is therefore essential to secure proper moisture results, inasmuch as experience has shown that the ore from different areas in one mine will vary materially in moisture.

With the moisture machine it is now possible to make dependable moisture determinations on structure drill cuttings which are invaluable in estimating the grades of unmined ore. Several of the independent mining companies operating wash-ore properties are interested in the machine, and its use may become standard, at least for preparing moisture samples on washed iron ores.

Chalchihuitl

A story of early turquoise mining in the Southwest

A view of the Cerillos Hills. The Mesozoic sediments have been stripped from these laccoliths. The hill to the left is Mount Chalchihuitl, where the turquoise mines are situated

E. R. Harrington

Former President, New Mexico Association for Advancement of Science, Albuquerque, N. M.

IN THIS YEAR OF 1940 the Southwest is celebrating a "Cuarto Centennial" to commemorate the entrance of Coronado, the Spanish Conqueror, into what is now the United States. He and his band made their entry into the Southwest in search of gold; gold that had already been mined and which could be had by taking through force of arms. One can imagine their chagrin when they found only great mud apartment houses inhabited by peaceful farmers to whom gold was practically unknown. These Indian farmers wore jewelry, to be sure, but it was chiefly of *turquoise,* taken from America's first mine.

Turquoise is a unique stone, being the only opaque mineral classed among the gems. The Persians supposed it to possess magical healing qualities and ability to protect its owner from injury. The Indians of Mexico prized it as a charm to keep away evil spirits and knew it as "chalchihuitl," the stone from the north. It is a stone found in the tombs of the Egyptian kings, and Pliny, the Roman observer, described it in some detail. During the middle ages the caravans brought the gem across from the orient, part of it coming from Turkey, whence it derived its name "turquoise."

Although the Spanish adventurers were looking for gold, they were not averse to taking other less valuable materials if nothing better afforded. Before 1600 they had found the place from which the turquoise came, about 20 miles southwest of what was later to become the site of Santa Fe. This was not difficult because a large open-pit mine is hard to hide, and here at Mount Chalchihuitl the Indians had been mining the gem for many years—perhaps even several centuries.

The work had been carried on with the crudest of equipment. The early miners had hacked at and beaten the

The modern drift through which the workers and visitors now gain entry to the old workings

rocks with huge stone axes attached to sticks or held with two hands. Great quantities of broken material had to be removed as they followed the turquoise stringers downward. Fires were built against the cliffs and water was dashed on the heated rocks to shatter them so that they might be broken away by the stone implements and carried out on the dump in crude skin buckets. Year after year the slow process continued and the open pits grew deeper and wider and the cliffs higher and more overhanging and the waste dumps larger. The veins led downward and fanned out horizontally, and soon the miners had followed them underneath the cliffs and out of the light of day. They had become America's first underground miners.

When was this? Who knows? Certainly it antedated the "Conquistadores," but was it 1440 or 1040? Ancient coiled pottery taken from the old workings indicates a very early date. Stone implements by the dozens have been taken from the workings and the dumps. The antiquity is a problem for the archaeologist and not the geologist, but it is not too extravagant to say that at least half of the great pit was probably excavated before the coming of the Spaniards in 1540.

The Spaniards took charge about 1600, the exact date being unimportant. They were true adventurers with the same cupidity of the soldier of fortune be he ancient, medieval, or modern. When these men saw a chance to create personal wealth by enslaving the early Indian miners they did so with no regrets, going to extremes of forced labor, a condition which undoubtedly contributed to the great Indian Revolt of 1680. In fact, the Indians were so fearful of the mines that they extracted a promise from the returning Spaniards that there was to be no more forced labor in them.

Up to 1680, however, the mines were madly exploited. Down and down the workings went. The mine dumps grew and the overhanging cliffs became more and more dangerous and finally the inevitable cave-in came! This rock-fall buried some of the Indians—how many no one knows—but a number of skeletons have been taken from beneath part of the fall of rock. Perhaps this disaster was a trigger that released the pent-up fury of the peaceful Indians. Whatever the cause, they banded together and expelled the Spaniards for several decades. Upon the return of the latter some of the mine works had fallen in. Others had been covered up. Trees were now growing on the old Chalchihuitl dump and in the pits. Desultory work was done, but it seemed as if the days of turquoise mining were over.

In 1858 W. P. Blake described the ancient workings in the *American Journal of Science,* marveling at the tremendous amount of work that had been done by the prehistoric miners. Interest lagged, however, until about 1880, by which time the mining boom at Leadville, Colo. had again focused attention on the West. The story of Mike O'Neil is typical of the boom that hit the Cerillos Hills in the eighties. Leaving Philadelphia in 1879, he got almost to Leadville. A conversation with a Spanish priest turned him southward to Santa Fe, and some time later he had re-located the old turquoise diggings. He tried to market the stones and after many difficulties did so. His old Tiffany mine furnished gem stones for twenty years.

Conflicting information has been printed as to the value of the output from the turquoise mines. Governor Miguel A. Otero in his report to the Secretary of the Interior for 1900 stated that more than 60 claims in the State, or Territory, of New Mexico were being worked. He listed annual outputs from $150,000 in 1891 to $475,000 in 1896. He told of one mine being sold for one quarter of a million dollars and one single stone bringing $6,000 on the New York market. The United States Geological Survey is more conservative in its estimates, giving the greatest year as $175,000. In recent years production has fallen off greatly. The old prehistoric workings at Mount Chalchihuitl are still operated in a small way by P. L. Schmidt, who has built up an extensive museum of materials taken from the workings. These old workings are one of the State's important, and worth-while, attractions for tourists.

Geologically, the Cerillos Hills are interesting. During the Laramide revolution the Mesozoic sediments of the region were extensively intruded by monzonite, causing them to dome up. Subsequent stripping of the sediments left the monzonite and porphyry cores standing out as domed hills and mountains. One of these hills is the Mount Chalchihuitl.

In many places the Cerillos laccoliths were badly shattered, and these fissures have acted as passageways for hot solutions and meteoric waters. Many unimportant veins of sulphide minerals are to be found below the water level and at one time lead and zinc were produced in the Cash Entry and Tom Paine mines, near Mount Chalchihuitl. The turquoise is found in the oxide zone, as would be expected of a hydrated phosphate of aluminum.

Entrance to the south pit, on Mount Chalchihuitl, today. Part of the talus has been removed and one of the ancient entrances uncovered at the right. Entrance is now made by the drift at the left

PERSONAL ITEMS

I. J. Simcox, recently general manager of Petsamon Nikkeli O/Y, Salmijarvi, Finland, with Mrs. Simcox, has returned to New York.

Scott Turner, of New York City, has resigned from the vice-presidency and board of directors of the International Mining Corporation.

Bernard D. Cullity has been appointed assistant professor of metallurgy at Montana School of Mines, succeeding **Dr. Ettore A. Peretti.**

M. Curley, for many years manager of New Cornelia branch of Phelps Dodge at Ajo, Ariz., has retired and will make his home in California.

Cleveland E. Dodge, vice-president of Phelps Dodge Corporation, has been awarded the Hundred Year Association Medal for outstanding service to the City of New York.

W. F. Boericke, chief valuation engineer for the Bureau of Mines, Manila, P. I., writes under date of May 14 that he has been doing examination recently in Surigao and Cagayan.

D. C. Sharpstone, Vancouver geologist, has left British Columbia for the East to take charge of Bralorne's wholly-owned subsidiary, Canbrae Exploration Company, with offices in Toronto.

Dr. A. W. G. Wilson, recently chief engineer of the minerals resources division, Mines Branch, Canadian Department of Mines and Resources, has been appointed chief technical consultant of the Mines and Geology Branch.

John A. Payne, a partner in the firm of Parrish & Company, in New York, was on May 9 elected president of Consolidated Coppermines Corporation. He succeeds **Boudinet Atterbury** as chief executive officer of the corporation.

Sydney H. Ball, New York mining engineer, was guest speaker on Watson Davis' "Adventures in Science" radio program on May 2. He talked on recent advances in the use of diamonds industrially.

Frank L. Sizer, dean of San Francisco consulting engineers, recently returned to his headquarters in the Hobart Building from Honduras, Central America, where he examined a mining property in the Jutigalpa district.

John R. Reigart, recently in charge of iron mining in northern Michigan for the Ford Motor Company, has joined the staff of the Beck Mining Company, which is operating a lead-zinc property in the Tri-State district.

George Warner, of Bisbee, Ariz., has been engaged by Shattuck Denn Mining Corporation to superintend the opening up of the mining claims of the 79 Lead-Copper Company near Hayden Junction, Pinal County, Ariz.

Prof. Walter H. Bucher, head of the department of geology at the University of Cincinnati, on the faculty of which institution he has served since 1911, has been appointed professor of geology at Columbia University. Shortly after his association with the University of Cincinnati, Professor Bucher received the Ph.D. degree summa cum laude from the University of Heidelburg. He is the author of an important work on geology,

PROF. WALTER H. BUCHER

"Deformation of the Earth's Crust," and was visiting professor at the University of California and Stanford University in 1926 and 1936 respectively. Professor Bucher is 58.

B. L. Thorne has retired from his position of mining engineer with the Calgary division of the department of natural resources of the Canadian Pacific Railway. He is succeeded by **J. B. de Hart.**

W. J. Loring, now chiefly engaged in the operation of placer properties in north-central California, has been retained as consulting engineer for the Midre d'Oro Mining Company, Ltd., according to a report from Plymouth, an early-day camp on the California Mother Lode, near which the company's property is situated.

L. R. Robins, who was manager during its productive period for the Tonopah Belmont Development Company and now with offices in Reno, Nev., has been engaged in mapping geology of a large area in the Silver City section of the Comstock district for several companies that are active in that territory, including the Dayton Consolidated Mines Company.

Dr. Arno C. Fieldner, chief of the technologic branch of the United States Bureau of Mines and a former president of the American Society for Testing Materials, has been awarded the Joseph Sullivant medal for "an admittedly notable achievement," by Ohio State University. Dr. Fieldner is an Ohio State alumnus.

David LeCount Evans, resident geologist during the past four years for the Climax Molybdenum Company in Colorado, is reported to have joined the staff of the Freeport Sulphur Company at its lately-established office in Reno, Nev.

Charles K. Leith, professor of geology at the University of Wisconsin, has been named by **Edward R. Stettinius, Jr.,** as an assistant in the task of coordinating the flow of industrial raw materials from mines to factories.

Russell Balconi, until recently with the Anvil mine of Pickands, Mather & Company, on the Gogebic range, has been transferred to the company's mines at Vulcan, Mich. **Carl Jauch,** mining engineer, with the company's Newport mine, has been transferred to the Anvil mine.

D. B. Hennessy, former secretary and assistant treasurer of the Anaconda Copper Mining Company, has resigned after 49 years of service. **James Dickson,** formerly comptroller, has been elected secretary and treasurer. **W. Kenneth Daly,** formerly general auditor, has been appointed comptroller.

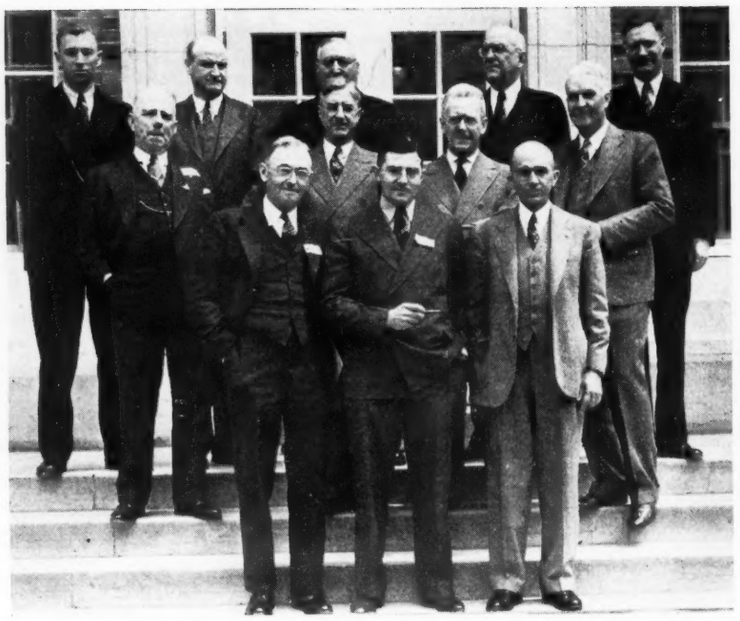
Verner A. Gilles, recently assistant chief geologist of the Northern Pacific Railway Company, has been appointed chief geologist, succeeding **E. H. MacDonald,** who is retiring after 32 years' service. **Karl A. E. Berg,** assistant geologist, has been named assistant chief geologist.

Dr. Ettore A. Peretti, who has been on the staff of the Montana School of Mines since 1936, has been appointed assistant professor of non-ferrous metallurgy at Columbia University. He will thus teach the subject taught for the past generation at Columbia by **Prof. Edward F. Kern,** who is going on sabbatical leave on July 1 with the intention of retiring at the end of the first semester in 1941. Dr. Peretti studied at Stuttgart, where he received the degree of doctor of science.

Raymond Brooks, with former office at 551 Fifth Ave., New York City, and active earlier in seeking and developing copper deposits in Rhodesia, is consulting engineer for the Silver Burro Exploration Company, with offices in Los Angeles, and in charge of development and diamond drilling on property of the Nevada-Keystone Mining Company, wholly-owned subsidiary of Silver Burro, operating in the old Central district in northern Pershing County, Nev.

S. G. Blaylock, president of the Consolidated Mining & Smelting Company of Canada, Ltd., has been awarded the gold medal of the Institution of Mining & Metallurgy, of London, "in recognition of his outstanding achievements in advancing the science of metallurgy in the Dominion of Canada." Mr. Blaylock is an alumnus of McGill University, Montreal. The award is the highest distinction within the gift of the Institution.

Prof. Rollin T. Chamberlin, of the University of Chicago, has given this year, at Northwestern University, Evanston, Ill., a series of lectures on the structures of the northern Rockies, commemorating the work of Prof. U. S. Grant, formerly chairman of the department of



Officers and directors of the Missouri Mineral Industries Conference, which met at the School of Mines and Metallurgy at Rolla, Mo., April 26 and 27. Front row, left to right: W. M. Weigel, of St. Louis, secretary-treasurer; Roy E. Mayes, of Carthage, president; A. E. Stocking, of De Soto, vice-chairman. Second row, left to right: Ben Reynolds, of Joplin; C. M. Butler, of Cape Girardeau; Dr. E. W. McCourt, of St. Louis; Earl Doane, of Poplar Bluff. Third row, left to right: Evan Just, of Joplin; George Fowler, of Joplin; T. Inkley, of Ste. Genevieve; Chief H. A. Buehler, of Rolla, and Dr. W. R. Chedsey, also of Rolla.

geology and geography at Northwestern. The instruction was under the auspices of the biennial Grant Memorial Lectures. Professor Chamberlain also delivered a lecture for laymen on the subject of earthquakes.

J. D. McClintock has severed his connection with Mammoth-St. Anthony, Ltd., and St. Anthony Mining & Developing Company, at Mammoth, Ariz. He was previously engaged in mining operations in Mexico and California and plans to return to private consulting practice, making headquarters in Tucson.

Roy E. Mayes, president of the Carthage Marble Company, was elected Chairman of the Missouri Mineral Industries Conference at the second meeting of this organization held on the campus of the School of Mines and Metallurgy at Rolla, on April 26 and 27. The Mineral Industries Conference, according to Dr. H. A. Buehler, head of the Missouri Geological Survey, was organized for the purpose of gaining a better knowledge of the possible services that can be rendered by the Missouri Geological Survey, the Missouri School of Mines, and the United States Bureau of Mines.

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OBITUARY

Alexander Longwell, one of the pioneers in opening the Cobalt camp in Ontario, Canada, died on April 25th last at Toronto.

S. J. Fitzgerald, prominently identified in the development of the Little Long Lac mining district, Ontario, Canada, died on April 13 last.

R. Bosustow, managing director of Bralorne Mines, who had been with that company for many years, died recently. He was formerly with American Metal.

James Adamson, a mining engineer who had retired from active practice of his profession 25 years ago, died at Purchase, N. Y., on May 10 at the age of 79.

General Otto H. Falk, chairman of the board of Allis-Chalmers Manufacturing Company, and long prominent in the military, civic, and industrial circles of Wisconsin, died on May 21 at the age of 74.

G. R. Southee, vice-president of the Canadian Ingersoll-Rand Company, and who had been associated with Canadian mining since the early days of the Cobalt discoveries, died recently in Toronto.

C. H. Wilson, who had for many years been in the service of the finance department of the Provincial Government of British Columbia, as consulting mining accountant and special auditor of income tax returns of mining corporations, died recently, at the age of 64.

P. W. George, formerly manager of Buchans Mining Company, Ltd., at Buchans, Newfoundland, who had had extensive mining experience in the United States and Canada, died recently in the bush from unknown causes, according to information received from the company mentioned.

Eugene Gilbert Sullivan, 54, mining engineer formerly employed by the Utah Copper Company at Bingham, died on April 25 at Halifax, N. S., while returning to Salt Lake City from the African gold coast, where he was employed by an English gold mining company. He was born May 4, 1885, in Greenland, Mich.

Max W. von Bernewitz, 61, mining and metallurgical engineer with the Eastern Experiment Station of the Bureau of Mines at College Park, Md., died on May 18 of a heart attack at his home in Hyattsville, Md. Mr. von Bernewitz had been a member of the technical staff of the Bureau of Mines for about seventeen years and was the author of numerous articles dealing with mining and metallurgical subjects, including a handbook for mineral prospectors. A native of New Zealand, Mr. von Bernewitz was educated at St. John's College and the Thames School of Mines there. He worked five years in New Zealand, twelve years in Australia, and a year in the Netherlands East Indies before coming to this country. He was a member of the editorial staffs of the *Mining and Scientific Press* in San Francisco, and the *Mines Handbook* in New York City, and worked with the Battelle Memorial Institute of Metallurgical Research, Columbus, Ohio. His widow, Mrs. Dorothea von Bernewitz, survives.

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LETTERS

Note of Appreciation From John W. Finch

The Editor:

TOWARD the end of April the Corcoran Art Gallery, Washington, D. C., sent me a beautiful painting by Eugen Weisz, entitled "Where the Saguenay and the St. Lawrence Rivers Meet." It was presented to me by members of the United States Bureau of Mines staff with a letter containing comments that I deeply appreciate. Their committee informs me that it was purchased "by contributions of from 10c. up"; therefore, a large part of the staff participated.

Their letter stated, among other things, that it "is a token of personal regard and appreciation of your wise and efficient administration of the Bureau of Mines from employees of the Washington office and the field." A bronze tablet on the picture is inscribed as follows:

"JOHN WELLINGTON FINCH

"We, your associates in the Bureau of Mines, wish that when this landscape falls within your vision, it will give you the same sense of tranquillity and trust that we so sincerely enjoyed for a period of years under your guidance.
Washington, D. C. April, 1940."

Naturally, I desire to make some pub-

lic acknowledgment and expression of appreciation of such a kind and thoughtful act by those with whom I have been associated happily for several years. If *Engineering and Mining Journal* will give this letter a place in its columns, the courtesy will be appreciated.

JOHN W. FINCH

New York, N. Y.

Bubble Action in the Deep Flotation Cell

The Editor:

I HAVE READ with much interest and pleasure A. W. Fahrenwald's "Survey of Mineral Dressing," as printed in your February issue. Such annual surveys are very important means of keeping the ordinary operator acquainted with the developments and improvements in the various phases of mineral dressing, and when, as in this article, the subject is treated in such excellent explanatory fashion, they provide a welcome stimulus to forward thinking in the industry.

The special reference to flotation cells, and particularly to the bubble action in the cell, is rather interesting in its application to pneumatic cells. In a pneumatic cell, where the air supplied not only aërates the pulp so that bubble formation is possible, but also causes the necessary circulation and agitation of the pulp so that adequate contact is induced between the mineral surface and the bubble film, it is obvious that the air supplied is much in excess of that required for ordinary froth formation. Hence any increase in the depth of a pneumatic cell, when the volume of free air supplied is kept constant, will have no such close correlation (from the aspect of available frothing air) with "the volume of air reaching the surface of the cell," as it would have in a mechanical cell where air is entrained by the action of the agitating mechanism or supplied by a special air line.

The characteristics of the froths formed by mechanical and pneumatic cells have also some bearing on the necessary cell surface. It is, I believe, generally agreed that the froth in a pneumatic cell has a larger average bubble size than that in a mechanical cell, so that it is freer and, if spread over too wide an area, tends to break down. This characteristic allows more variation in the depth of the froth column and also in the rate of discharge of froth per unit of froth surface area than in the mechanical cell, while the same free character of the froth allows the less easily attached gangue particles to drop out.

The general effect of putting five times the amount of feed through a deep cell with the same frothing area as a shallow cell, is to produce a clean, well-loaded froth at the head end of the machine. The general appearance of this froth is analogous to that occurring in the first cell of a battery of mechanical cells. Towards the tail end of the deep cell, where a scavenging action obtains, it is generally beneficial to raise the froth discharge lip from two to five inches above the level at the head end. Because of the thorough aërating action of the deep cell, the froth flows very freely over the entire length of the cell without the use of any skimming devices. At the tail end, the deep froth column produces a clean middling concentrate which contains a very small amount of entrained gangue.

In actual practice, it has been found, with tests on the deep cell, that increasing the frothing area is not a desirable change and the increase of cell area in direct proportion to the increase in cell volume would, in this particular type of cell, prove to be very unsatisfactory.

The Britannia deep cell has been tested at Britannia and Chelan against pneumatic cells of the ordinary shallow type and against one of the best-known mechanical cells, both on roughing and cleaning operations, with results, when treating these particular ores, definitely in favor of the deep cell, both in metallurgical efficiency and in low power consumption. The operators at Britannia are not actively interested in furthering the use of this cell elsewhere, but wish to give other operations the benefit of their experience with it.

There is one likely error into which operators may fall in testing the deep cell against other machines, and that is to substitute a deep cell of equal volume and of correspondingly reduced length for a longer but shallower Forrester cell or for a battery of mechanical cells. In such a case, just as when a large mechanical cell would replace a row of similarly shaped but smaller mechanical cells and of equal total volume, the effect of short circuiting a portion of the charge would come into play. For this same reason ten unit cells in series when treating the maximum economic tonnage will always show improved extraction of mineral values over the same cells placed in parallel and handling in each case one-tenth of the tonnage. For adequate testing where a deep cell has say five times the cross-sectional area of a 100-ft. shallow cell, the deep cell should be made 100 ft. long and should be tested against five 100-ft. shallow cells in parallel or with five times the feed against one 100-ft. shallow cell. Even better results should be obtained from our experience in substituting a long deep cell for several shorter shallow cells, acting in parallel, of total volume equal to that of the deep cell.

In any flotation machine cell, volume is an extremely important factor to consider, in that it governs the length of time of the average particle of feed in the cell, but it is equally important that such a machine should have a satisfactory relationship between its cross-sectional area and its length. In two cells of equal volume but of different length, the probability of escape of some mineral particles without coming into contact with a bubble film is much greater with the short cell than with the longer one, and this fact will be reflected in lower extraction from the short cell.

Though it would be impossible to give a standard relationship between cross-sectional area and the length of cell which would give the best results in all cases, it is important that, in any test, the deep cell should have approximately the same dimensional relationship as the cell installation against which it is to be tested.

NORMAN A. MACLEOD, Metallurgist

San Juan County Commissioners Move to Aid Colorado Mining

The Editor:

TAXES on many patented mining claims in San Juan County, Colo., have become delinquent for various reasons not necessarily reflecting on the merits of the properties. Delinquency has occurred, here as elsewhere, during periods of low metal prices and business depression.

In an effort to revive interest in these properties, many of which show considerable merit, the Board of County Commissioners is cooperating by offering delinquent tax certificates on about 1,200 patented mining claims. These properties are in groups of from a single claim to as many as forty, and if sold as groups the tax certificates will in most cases be offered for $100 per claim.

Colorado tax laws provide for the issuance of tax deed after proper publication. In the event of redemption by an owner before title is secured, all taxes, interest, etc., assessed against the property must be paid to the purchaser of the certificate. This amount would frequently exceed many times the cost of the certificate.

After securing a tax deed it is probably advisable to quiet title in the District Court. In many cases it may be found possible for a nominal sum to secure deed from the owner, or make a working agreement whereby a small interest in operating profits might eliminate the delay in acquiring and clearing title.

For the purpose of assembling data to assist in intelligent prospecting and investigation, a survey has been made which includes data from local papers since 1886, showing the work done on various properties and the size and value of the orebodies encountered. It has also been possible to check some of this information with engineers' reports and smelter settlements. The data assembled not only give valuable information for prospecting purposes, but in many cases indicate underground workings that may be reached by clearing tunnel entrances for a small cost.

The County Commissioners do not encourage consideration of these opportunities without actual inspection of properties. Due to altitude, surface inspection should not be attempted before June, at which time the files covering these properties will be complete and available for inspection at the Court House in Silverton, Colo. Such inspection is invited.

Many eminent geologists and engineers believe that San Juan County is the most highly mineralized district in the State. Considering the revaluation of gold, the remonetization of silver, the development of modern mining and milling methods, and the availability of local custom mill facilities, it is possible that some of the tax-delinquent properties could be profitably operated.

B. F. WEBSTER, JR.

Silverton, Colo.

Summary of the

MARKETS

FOLLOWING a brief period of quiet and some unsettlement in prices, the market for non-ferrous metals responded to the news that Germany had invaded the Low Countries by renewed buying and a generally firmer undertone. President Roosevelt's billion-dollar rearmament program also inspired some buying. Late in May the Allies came into the domestic market for copper and zinc. The *E.&M.J.* index of non-ferrous metal prices for May was 77.68, against 77.19 in April, the moderate advance reflecting higher monthly averages for zinc, tin, and foreign silver.

Sales of copper in the domestic market for May totaled 84,232 tons, which compares with 41,641 tons in April. Domestic consumption of copper increased, largely on rearmament orders. After selling down to 11¼c., Valley, the price firmed up toward the end of the month and all sellers moved back to the 11½c. basis.

France renewed its option for 25,000 tons of foreign copper monthly, to be delivered during September-October-November. The price mentioned on this deal was 11¼c., f.a.s. United States ports. Since the outbreak of hostilities, France has purchased a total of 375,000 tons of copper. Export copper averaged a little lower in price during May than in the preceding month.

The United States market for lead eased on the threat of larger imports. Lead produced from foreign ore was offered at a shade under 3.30c., Atlantic ports, duty unpaid.

Export and domestic demand for zinc improved and the price was raised by some sellers to 6c., St. Louis, May 24. However, the uplift of one-quarter cent became general on the following day. Tin was higher on fears of shipping complications in the Far East. Silver was higher in the foreign market on increased buying here to avoid new British export regulations. Quicksilver was up on uncertainty about Italy's position in the war.

UNITED STATES MARKET

1940	Electrolytic Copper Domestic (a) Refinery	Electrolytic Copper Export (b) Refinery	Straits Tin New York	Lead New York	Lead St. Louis	Zinc St. Louis
May						
1	11.025	11.050	47.250	5.10	4.95	5.75
2	10.900	11.000	47.375	5.10	4.95	5.75
3	10.900	11.025	47.375	5.10	4.95	5.75
4	10.900	11.000	47.125	5.10	4.95	5.75
6	10.900	11.025	47.125	5.00	4.85	5.75
7	10.850	11.025	47.500	5.00	4.85	5.75
8	10.850	10.950	47.625	5.00	4.85	5.75
9	10.825	10.900	47.625	5.00	4.85	5.75
10	11.150	11.000	53.500	5.00	4.85	5.75
11	11.275	11.250	54.500	5.00	4.85	5.75
13	11.275	11.325	54.000	5.00	4.85	5.75
14	11.150@11.275	11.325	52.500	5.00	4.85	5.75
15	11.150@11.275	11.250	51.500	5.00	4.85	5.75
16	11.275	11.325	52.500	5.00	4.85	5.75
17	11.150@11.275	11.325	53.500	5.00	4.85	5.75
18	11.150	11.300	54.000	5.00	4.85	5.75
20	11.150	11.300	54.000	5.00	4.85	5.75
21	11.025	11.275	53.875	5.00	4.85	5.75
22	11.025	11.250	53.875	5.00	4.85	5.75
23	11.025	11.275	53.500	5.00	4.85	5.75
24	11.025	11.275	53.000	5.00	4.85	5.75@6.00
25	11.150	11.250	52.700	5.00	4.85	6.00
27	11.175	11.300	52.500	5.00	4.85	6.00
28	11.150	11.250	53.500	5.00	4.85	6.00
29	11.150	11.275	53.875	5.00	4.85	6.00
30	Holiday	11.300	Holiday	Holiday	Holiday	Holiday
31	11.275	11.325	55.000	5.00	4.85	6.00
	AVERAGES FOR MONTH					
	11.079	11.191	51.570	5.015	4.865	5.803
May	**AVERAGES FOR WEEK**					
1	11.025	11.204	47.417	5.100	4.950	5.750
8	10.883	11.004	47.354	5.050	4.900	5.750
15	11.158	11.175	52.271	5.000	4.850	5.750
22	11.140	11.296	53.625	5.000	4.850	5.750
29	11.113	11.271	53.179	5.000	4.850	5.938
May	**CALENDAR WEEK AVERAGES**					
4	10.963	11.075	47.292	5.100	4.950	5.750
11	10.975	11.025	49.646	5.000	4.850	5.750
18	11.223	11.308	53.000	5.000	4.850	5.750
25	11.067	11.271	53.492	5.000	4.850	5.813

SILVER, GOLD AND STERLING EXCHANGE

1940	Sterling Exchange "Checks"	Sterling Exchange "90-day demand"	Silver (c) New York	Silver London	Gold London	Gold (d) United States
May						
1	348.0000	343.7500	34.750	21.4375	168s	$35.00
2	349.5000	345.2500	34.750	21.5000	168s	35.00
3	347.0000	342.7500	34.750	21.0625	168s	35.00
4	346.0000	341.7500	(e)	(e)	(e)	35.00
6	344.5000	340.2500	34.750	21.0625	168s	35.00
7	337.2500	332.7500	34.750	21.0000	168s	35.00
8	333.0000	328.5000	34.750	20.8750	168s	35.00
9	333.7500	329.5000	34.750	21.0000	168s	35.00
10	312.0000	306.0000	34.750	21.0000	168s	35.00
11	321.0000	315.5000	(e)	(e)	(e)	35.00
13	321.0000	315.0000	34.750	21.1875	168s	35.00
14	317.0000	310.2500	34.750	22.5000	168s	35.00
15	322.7500	317.0000	34.750	23.0625	168s	35.00
16	323.0000	317.5000	34.750	23.5000	168s	35.00
17	323.0000	318.0000	34.750	23.5000	168s	35.00
18	318.0000	313.5000	(e)	(e)	(e)	35.00
20	325.0000	320.5000	35.000	22.6250	168s	35.00
21	318.0000	313.7500	35.000	22.5625	168s	35.00
22	322.5000	319.5000	35.000	21.1875	168s	35.00
23	321.0000	317.5000	35.125	21.8125	168s	35.00
24	319.5000	315.7500	35.250	22.4375	168s	35.00
25	319.0000	315.5000	(e)	(e)	(e)	35.00
27	318.0000	314.5000	35.375	22.3125	168s	35.00
28	313.0000	309.3750	35.625	22.0000	168s	35.00
29	317.0000	313.5000	35.625	22.0000	168s	35.00
30	Holiday	Holiday	Holiday	21.8750	168s	Holiday
31	318.0000	314.5000	35.125	21.6875	168s	35.00
	AVERAGES FOR MONTH					
	326.452	.....	34.949	21.878	....	35.00
May	**AVERAGES FOR WEEK**					
1	350.042	.....	34.750	.....	....	....
8	342.875	.....	34.750	.....	....	....
15	321.250	.....	34.750	.....	....	....
22	321.583	.....	34.900	.....	....	....
29	317.917	.....	35.400	.....	....	....

Calendar week averages, New York Silver; May 4th, 34.750; 11th, 34.750; 18th, 34.750; 25th, 35.075.

(e) Not quoted (Saturday).

THE above quotations for major non-ferrous metals are our appraisal of the important United States markets, based on sales reported by producers and agencies. They are reduced to the basis of cash, New York or St. Louis, as noted. All prices are in cents per pound.

(a) Net prices at refineries on Atlantic seaboard. To arrive at the delivered New England basis add 0.225c. per pound, the average differential for freight and delivery charges.

(b) Export prices are net at refineries on the Atlantic seaboard and include sales of domestic copper in the foreign market. Owing to the European War and the disruption of normal trade relations, our export copper quotations, since September, 1939, have been based largely on f.a.s. transactions, ex United States ports. To arrive at the f.o.b. refinery quotation deduct .05 from the f.a.s. basis for lighterage.

Copper, lead and zinc quotations are based on sales for both prompt and future deliveries; tin quotations are for prompt delivery only.

Quotations for copper are for the ordinary forms of wirebars and ingot bars; cathodes are sold at a discount of 0.125c.

Quotations for zinc are for ordinary Prime Western brands. Zinc in New York commands a premium over the St. Louis basis equal to the freight differential. Contract prices for High Grade zinc delivered in the East and Middle West in nearly all instances command a premium of 1c per pound over the current market for Prime Western but not less than 1c over the *Engineering and Mining Journal's* average quotation for Prime Western for the previous month.

Quotations for lead reflect prices obtained for common lead, and do not include grades on which a premium is asked.

(c) Silver other than newly-mined domestic, by Handy & Harman. Under Treasury order of July 6, 1939, the price on domestic newly-mined silver mined subsequent to July 1, 1939, was fixed at 71.11c per troy ounce. Handy & Harman's quotation on newly-mined domestic silver, 999 fine was 70⅝c throughout May.

(d) U. S. Treasury's gold price. Actual payment by the United States Treasury for gold in domestic and imported ore or concentrate is at 99.75 per cent of the price quoted by the Treasury, which at present is equal to $34.9125.

PRICES OF METALS • MISCELLANEOUS QUOTATIONS

LONDON MARKET

1940 May	Copper Standard Spot	Copper Standard 3 months	Copper Electro Bid	Tin Standard Spot	Tin Standard 3 months	Lead Spot Buyers	Lead Spot Sellers	Lead 3 months Buyers	Lead 3 months Sellers	Zinc Spot Buyers	Zinc Spot Sellers	Zinc 3 months Buyers	Zinc 3 months Sellers
1	Not quoted			253.0000	249.7500	Not quoted							
2	"	"	"	254.5000	251.7500	"	"	"	"	"	"	"	"
3	"	"	"	254.0000	251.7500	"	"	"	"	"	"	"	"
6	"	"	"	253.7500	251.7500	"	"	"	"	"	"	"	"
7	"	"	"	255.0000	252.7500	"	"	"	"	"	"	"	"
8	"	"	"	255.0000	252.7500	"	"	"	"	"	"	"	"
9	"	"	"	255.0000	253.0000	"	"	"	"	"	"	"	"
10	"	"	"	263.0000	261.2500	"	"	"	"	"	"	"	"
13	"	"	"	269.5000	267.5000	"	"	"	"	"	"	"	"
14	"	"	"	265.2500	262.7500	"	"	"	"	"	"	"	"
15	"	"	"	261.2500	258.2500	"	"	"	"	"	"	"	"
16	"	"	"	265.2500	263.0000	"	"	"	"	"	"	"	"
17	"	"	"	269.5000	266.5000	"	"	"	"	"	"	"	"
20	"	"	"	269.5000	267.2500	"	"	"	"	"	"	"	"
21	"	"	"	270.5000	268.0000	"	"	"	"	"	"	"	"
22	"	"	"	270.2500	268.0000	"	"	"	"	"	"	"	"
23	"	"	"	269.5000	267.2500	"	"	"	"	"	"	"	"
24	"	"	"	267.5000	265.2500	"	"	"	"	"	"	"	"
27	"	"	"	266.7500	265.2500	"	"	"	"	"	"	"	"
28	"	"	"	268.0000	265.2500	"	"	"	"	"	"	"	"
29	"	"	"	270.0000	268.0000	"	"	"	"	"	"	"	"
30	"	"	"	273.5000	271.2500	"	"	"	"	"	"	"	"
31	"	"	"	274.7500	273.0000	"	"	"	"	"	"	"	"
Average for month				264.098									

Prices for tin are the official prices of the London Metal Exchange, in long tons (2240 lb.). Trading in other metals remained suspended.

CURRENT PRICES — MISCELLANEOUS METALS, ORES, AND NON-METALLIC MINERALS

Quotations cover wholesale lots, prompt shipment, f.o.b. New York, unless otherwise stated

(June 1, 1940)

MISCELLANEOUS METALS

Aluminum, ingot, 99 plus per cent, lb	19c.
Antimony, domestic, spot, lb	14.00c.
Bismuth, ton lots, lb	$1.25
Cadmium, commercial sticks, lb	80c.
Calcium, lb., ton lots 97 @ 98 per cent	Nominal
Chromium, 97 per cent grade, lb	89c.
Cobalt, 97 to 99 per cent, per lb	$1.50
Nickel, electrolytic cathodes, lb	35c.
Magnesium, 99.8 per cent, carloads, lb	27c.
Palladium, troy oz	$24.00
Platinum, (Official quotation) troy oz	$38.00
Quicksilver, flask of 76 lb., 100 flasks or more	$195.00
Radium, mg. radium content	$25.00@$30.00
Selenium, 99.5 per cent, lb	$1.75
Silicon, minimum 97 per cent, spot, lb	16.50c.
Tellurium, lb	$1.75
Thallium, 100 lb. or more, lb	$6.50
Titanium, 96 to 98 per cent, lb	$5.00

METALLIC ORES

Beryllium Ore, f.o.b. mines, ton	$30.00@$35.00
Chrome Ore, 48 @ 50% Cr_2O_3 c.i.f. Atl. ports, long ton	$29.00@$30.00
Iron Ore, Lake Superior, Lower Lake ports, long ton:	
Old Range bessemer	$4.75
Mesabi bessemer	$4.60
Old Range non-bessemer	$4.60
Mesabi, non-bessemer	$4.45
Lead (Galena) 80 per cent, Joplin, Mo., ton	$58.34
Manganese Ore, (foreign) c.i.f. U.S. ports, long ton unit of Mn:	
52 @ 55 per cent	(b) 50c.
50 @ 52 per cent	(b) 50c.
46 @ 48 per cent	(b) 48c.
Molybdenum Ore, 90%, per lb. of MoS_2, f.o.b. mines	45c.
Tungsten Ore, per unit of WO_3:	
Chinese, 65 per cent, duty paid	$23.50
Domestic, 65 per cent and upward	(a)$22.00@$23.00
Vanadium Ore, per lb. of contained V_2O_5	27½c.
Zinc Ore, Prime, 60 per cent concentrate, Joplin, Mo.; per ton	$39.00

(a) Prices at mines, small lots, usually several dollars less. (b) Nominal.

METALLIC COMPOUNDS

Arsenious Oxide (arsenic) lb	3c.
Cobalt Oxide, 70 @ 71 per cent, lb	$1.84
Copper Sulphate, 100 lb	$4.60
Sodium Nitrate, ex vessel, in 200-lb. bags, per 100 lb	$1.42
Sodium Sulphate, bulk ton	$13.00@$15.00

ALLOYS

Berryllium Copper, master alloy, 2.5 to 3 per cent Be, per lb. of contained Be	$15.00
Ferrochrome, 65 @ 70 per cent chromium, 4 @ 6 per cent carbon, lb	11c.
Ferromanganese, 78 @ 82 per cent, gross ton	$100.00
Ferromolybdenum, 55 @ 65 per cent Mo. lb. of Mo. contained	95c.
Ferrosilicon, 50 per cent, gross ton	$69.50
Ferrotungsten, 75 @ 80 per cent, lb. of W contained	$1.90@$2.00

NON-METALLIC MINERALS

Asbestos, f.o.b. mines, ton:	
Canadian (Quebec)	
Crude No. 1	$700@$750
Crude No. 2	$150@$350
Spinning fibers	$110@$200
Paper stock	$40@$45
Shorts	$12@$16.50
Vermont	
Shingle stock	$57
Paper stock	$40
Cement stock	$25
Barytes, long ton:	
Georgia, crude	$7.00
Missouri, 93 per cent $BaSO_4$, less than 1 per cent iron	$6.00@$6.50
Bauxite, long ton:	
Domestic, chemical, 55 @ 58 per cent	$6.00@$7.00
Domestic, abrasive, 80 @ 84 per cent	$13.00@$14.00
Dalmatian, 50 @ 55 per cent	Nominal
French, 56 @ 59 per cent	(a)$7.00 @$8.00
China Clay, f.o.b. mines, ton:	
South Carolina and Georgia, No. 1, bulk	$6.75@$8.00
Delaware, No. 1	$14.50
Feldspar, bulk, ton:	
Potash feldspar, 200 mesh	$17.00
Glass-spar, white, 20 mesh	$11.75
Fluorspar, f.o.b. mines, bulk, Kentucky and Illinois 85–5 per cent, all rail movement, ton	$20.00
Fuller's earth, f.o.b. Georgia or Florida, ton	$7.00@$14.00
Magnesite, per ton:	
Dead-burned, f.o.b. California	$25.00
Dead-burned, f.o.b. Washington	$22.00
Mica, per lb., North Carolina, No. 1 and 2 quality:	
1½ x 2 in.	35@40c.
2 x 2 in.	60@70c.
3 x 3 in.	$1.35@$1.45
3 x 4 in.	$1.60@$1.70
3 x 5 in.	$2.00@$2.25
White, ground, 70 mesh, ton	$60.00@$80.00
Ocher, Georgia, ton	$19.00@$22.00
Pyrites, Spanish, per long ton unit of S, c.i.f. Atlantic ports	(a) 12c.
Silica, in bags, 325 mesh, ton	$20.00@$40.00
Sulphur, Texas, mines, long ton	$16.00
Talc, f.o.b. works, ton:	
New York, double air-floated, 325 mesh	$12.00@$15.00
New Jersey, mineral pulp	$8.00@$10.00
Vermont, extra white, 200 mesh	$9.00@ $9.50
Tripoli, Missouri, ton:	
40 mesh, cream colored	$14.50
200 mesh, cream colored	$26.00

(a) Nominal

IRON AND STEEL

Pig Iron, Valley furnaces, gross ton:	
Bessemer	$23.50
Basic	$22.50
No. 2 Foundry	$23.00
Steel, base prices, Pittsburgh:	
Billets, gross ton	$34.00
Structural shapes, 100 lb	$2.10
Bars, 100 lb	$2.15

Monthly and Yearly

AVERAGE PRICES

SILVER AND STERLING EXCHANGE

	New York		London Spot		Sterling Exchange	
	1939	1940	1939	1940	1939	1940
January	42.750	34.750	20.305	21.892	466.775	395.442
February	42.750	34.750	20.370	20.935	468.472	395.652
March	42.750	34.750	20.280	20.763	468.370	375.212
April	42.750	34.750	20.031	20.713	467.778	351.817
May	42.750	34.949	20.123	21.878	467.988	326.452
June	41.955	.....	19.505	.....	468.137	.....
July	34.944	.....	16.952	.....	468.031	.....
August	35.951	.....	17.719	.....	460.383	.....
September	36.956	.....	22.178	.....	398.820	.....
October	35.726	.....	22.736	.....	400.350	.....
November	34.750	.....	23.378	.....	391.457	.....
December	34.956	.....	23.263	.....	391.830	.....
Year	39.082	.....	20.570	.....	443.199	.....

New York quotations for silver other than newly-mined domestic, cents per ounce troy, 999 fine, London pence per ounce sterling silver 925 fine. Sterling exchange (pound sterling) in cents.

COPPER

	F.O.B. Refinery, Electrolytic				London Spot			
	Domestic		Export		Standard		(a) Electrolytic	
	1939	1940	1939	1940	1939	1940	1939	1940
January	11.025	11.954	9.912	11.999	43.125	(b)	48.440	(b)
February	11.025	11.148	9.735	11.471	42.188	(b)	47.375	(b)
March	11.025	11.160	9.888	11.407	42.938	(b)	48.120	(b)
April	10.265	11.087	9.820	11.258	42.031	(b)	47.853	(b)
May	9.833	11.079	9.738	11.191	41.656	(b)	47.528	(b)
June	9.775	.....	9.738	.....	41.986	.....	47.528	.....
July	9.976	.....	9.944	.....	42.809	.....	48.863	.....
August	10.261	.....	10.211	.....	44.685	.....	50.409	.....
September	11.635	.....	11.685	.....	(b)	.....	(b)	.....
October	12.215	.....	12.491	.....	(b)	.....	(b)	.....
November	12.275	.....	12.929	.....	(b)	.....	(b)	.....
December	12.275	.....	12.631	.....	(b)	.....	(b)	.....
Year	10.965	.....	10.727	....	(c) 42.689	.....	(c) 48.262	.....

New York quotations, cents per pound. London, pounds sterling per long ton. (a) Bid quotations. (b) No quotations. (c) Average for eight months.

LEAD

	New York		St. Louis		London			
	1939	1940	1939	1940	1939 Spot	1939 3 mos.	1940 Spot	1940 3 mos.
January	4.826	5.471	4.676	5.321	14.534	14.744	(a)	(a)
February	4.805	5.076	4.655	4.926	14.283	14.417	(a)	(a)
March	4.824	5.192	4.674	5.042	14.660	14.860	(a)	(a)
April	4.782	5.071	4.632	4.921	14.337	14.533	(a)	(a)
May	4.750	5.015	4.600	4.865	14.483	14.679	(a)	(a)
June	4.800	.....	4.650	.....	14.564	14.651	.....	.....
July	4.854	.....	4.704	.....	14.753	14.856	.....	.....
August	5.043	.....	4.893	.....	16.040	15.885	.....	.....
September	5.449	.....	5.299	.....	(a)	(a)	.....	.....
October	5.500	.....	5.350	.....	(a	(a)	.....	.....
Novemoer	5.500	.....	5.350	.....	(a)	(a)	.....	.....
December	5.500	.....	5.350	.....	(a)	(a)	.....	.....
Year	5.053	.....	4.903	....	(b) 14.707	(b) 14.828	.....	.....

New York and St. Louis quotations, cents per pound. London pounds sterling per long ton. (a) No quotations. (b) Average for eight months.

TIN

	Straits, New York		Standard, Spot, London	
	1939	1940	1939	1940
January	46.404	46.707	215.435	240.716
February	45.640	45.851	213.906	242.833
March	46.213	47.079	215.375	251.711
April	47.160	46.815	218.389	252.080
May	49.031	51.570	225.591	264.098
June	48.853	.....	227.511	.....
July	48.548	.....	229.833	.....
August	48.793	.....	229.869	.....
September	64.588	.....	229.292	.....
October	55.580	.....	229.943	.....
November	52.322	.....	230.000	.....
December	50.740	.....	248.974	.....
Year	50.323	.....	226.177	.....

New York quotations, cents per pound. London, pounds sterling per long ton.

ZINC

	St. Louis		London			
	1939	1940	1939 Spot	1939 3 mos.	1940 Spot	1940 3 mos.
January	4.500	5.644	13.682	13.887	(a)	(a)
February	4.500	5.534	13.522	13.780	(a)	(a)
March	4.500	5.750	13.728	13.961	(a)	(a)
April	4.500	5.750	13.443	13.637	(a)	(a)
May	4.500	5.803	13.717	13.938	(a)	(a)
June	4.500	.....	14.023	14.223	.....	.....
July	4.516	.....	14.235	14.435	.....	.....
August	4.719	.....	14.628	14.761	.....	.....
September	6.104	.....	(a)	(a)	.....	.....
October	6.500	.....	(a)	(a)	.....	.....
November	6.500	.....	(a)	(a)	.....	.....
December	5.980	.....	(a)	(a)	.....	.....
Year	5.110	.....	(b) 13.872	(b) 14.078	.....	.....

St. Louis quotations, Prime Western, cents per pound. London, pound sterling per long ton. (a) No quotations. (b) Average for eight months.

CADMIUM AND ALUMINUM

	Cadmium		Aluminum	
	1939 (a)	1940 (a)	1939	1940
January	58.400	79.038	20.000	20.000
February	55.000	80.000	20.000	20.000
March	54.259	80.000	20.000	19.769
April	50.000	80.000	20.000	19.000
May	50.000	80.000	20.000	19.000
June	50.000	.....	20.000	.....
July	50.000	.....	20.000	.....
August	53.704	.....	20.000	.....
September	64.200	.....	20.000	.....
October	74.600	.....	20.000	.....
November	75.000	.....	20.000	.....
December	75.000	.....	20.000	.....
Year	59.180	.....	20.000	.....

Aluminum in cents per pound, 99 plus per cent grade. Cadmium, cents per pound. (a) Producers' price, commercial sticks.

ANTIMONY, QUICKSILVER, AND PLATINUM

	Antimony (a) New York		Quicksilver (b) New York		Platinum (c) New York	
	1939	1940	1939	1940	1939	1940
January	11.670	14.000	77.440	156.962	34.440	40.000
February	11.250	14.000	85.227	178.000	35.000	40.000
March	11.269	14.000	87.278	180.921	35.000	40.000
April	11.500	14.000	90.800	173.538	35.000	38.923
May	11.712	14.000	86.769	181.538	35.000	38.000
June	12.000	.....	86.615	.....	35.000	.....
July	12.000	.....	86.960	.....	35.000	.....
August	12.000	.....	84.407	.....	35.333	.....
September	12.910	.....	140.000	.....	40.080	.....
October	14.000	.....	145.600	.....	41.120	.....
November	14.000	.....	134.978	.....	40.000	.....
December	14.000	.....	141.200	.....	40.000	.....
Year	12.359	.....	103.940	.....	36.748	.....

(a) Antimony, cents per pound, ordinary brands, in cases; in bulk 13.415 for May. (b) Quicksilver, dollars per flask of 76 lb. (c) Platinum, dollars per ounce troy.

PIG IRON

	Bessemer		Basic		No. 2 Foundry	
	1939	1940	1939	1940	1939	1940
January	21.50	23.50	20.50	22.50	21.00	23.00
February	21.50	23.50	20.50	22.50	21.00	23.00
March	21.50	23.50	20.50	22.50	21.00	23.00
April	21.50	23.50	20.50	22.50	21.00	23.00
May	21.50	23.50	20.50	22.50	21.00	23.00
June	21.50	.....	20.50	.....	21.00	.....
July	21.50	.....	20.50	.....	21.00	.....
August	21.50	.....	20.50	.....	21.00	.....
September	22.50	.....	21.50	.....	22.00	.....
October	23.50	.....	22.50	.....	23.00	.....
November	23.50	.....	22.50	.....	23.00	.....
December	23.50	.....	22.50	.....	23.00	.....
Year	22.083	.....	21.083	.....	21.583	.....

Iron, dollars per long ton. F.o.b. Mahoning and Chenango Valley furnaces.

What Metal Statistics Show

PLANS for greater national defense served as a signal to mine operators to appraise the condition of their supplies and equipment to meet any future national emergency that would require a greater output of metals. President Roosevelt appointed Edward R. Stettinius, Jr., chairman, United States Steel Corporation, to supervise production of raw materials with which to fill government orders and their treatment up to the time of starting fabricated products. Charles K. Leith, professor of geology, University of Wisconsin, was named by Mr. Stettinius to assist in the task of coordinating the flow of industrial raw materials from mines to places of consumption.

Meanwhile, producers of lead have observed a peculiar influence on markets for their product, following the German invasion of Holland and Belgium in May. These two countries, together with Norway, Denmark, and Sweden, were fairly substantial consumers of lead, but when they came into the German sphere of economic influence, foreign lead producers sought other markets, not overlooking the United States. This action has forced domestic producers to maintain a price level for lead comparable with that of imported lead. Removal of these foreign lead offerings would strengthen the position of the domestic producers. The decline of domestic refined lead output in April was due to labor difficulties at one refinery and the effect of a temporary shutdown of another plant pending accumulation of concentrates. Refined production in May is expected to be around 42,000 tons.

The zinc situation is almost the opposite of lead, due to the German control of Belgium, which is the second largest zinc-smelting country in the world. Neutrals and belligerents formerly supplied with zinc from Belgium are seeking other sources of supply, making numerous inquiries in the United States. This action has resulted in higher prices for domestic zinc. Domestic mine production of zinc has been irregular, influenced in a large measure by the depressing influence of the present zinc tariff. Supplies, therefore, are now tight, when demand is increasing.

The International Tin Committee on May 27 increased production quotas of the signatory countries to 100 per cent of the standard rate effective in the third quarter of the year. Advices from abroad indicate that Germany obtained 2,000 tons of tin in Holland.

Demand for copper improved in May, and with this country seeking ample supplies of raw materials, production at the mines during the summer months may not experience the rate of curtailment producers had expected.

Domestic shipments to customers increased during April, but this development failed to check the upward trend in supplies in the hands of producers, owing in part to another reduction in exports. Stock of refined copper increased 9,325 tons.

The latest duty-free copper statistics of the Copper Institute, in short tons, follow:

	Production	
	(a) Crude	Refined
January	89,598	80,501
February	76,145	82,761
March	(b)85,796	86,295
April	84,744	80,964
Totals	336,283	330,521

	Deliveries to Customers		
	Domestic	Export	Totals
January	91,428	13,117	104,545
February	63,215	9,594	72,809
March	64,376	7,517	71,893
April	68,665	2,974	71,639
Totals	287,684	33,202	320,886

	(c) Refined Stocks End of Month
January	135,441
February	145,393
March	159,795
April	169,120

(a) Mine or smelter production or shipments, and custom intake including scrap. (b) Corrected. (c) At refineries, on consignment and in Exchange warehouses, but not including consumers' stocks at their plants or warehouses.

▶LEAD—Domestic stocks of refined lead at the end of April amounted to 63,463 tons, a decrease of 11,229 tons compared with figures for a month previous, the American Bureau of Metal Statistics reports. Total production declined to 35,343 tons. Shipments to consumers increased slightly from 46,353 tons in March to 46,563 tons in April.

The March and April statistics for refined lead, in tons, follow:

	March	April
Stock at beginning	72,658	74,692
Production:		
From domestic ore	44,783	31,192
Secondary and foreign	3,617	4,151
Totals	48,400	35,343
Domestic shipments	46,353	46,563
Stock at end	74,692	63,463

E & M J Weighted Index of Non-Ferrous Metal Prices

(100 is composite for 1922–3–4)

1929	110.33	1934	69.59
1930	82.87	1935	74.66
1931	69.20	1936	73.45
1932	48.26	1937	90.86
1933	59.79	1938	73.67
	1939	77.71	

	1938	1939	1940
January	75.56	77.12	80.85
February	73.43	76.89	77.23
March	72.41	77.09	77.94
April	71.19	74.79	77.19
May	69.15	73.61	77.68
June	67.55	73.17	.....
July	72.95	71.95	.....
August	73.94	73.88	.....
September	74.70	83.07	.....
October	77.61	84.25	.....
November	78.36	83.80	.....
December	77.13	82.89	.....

▶MANGANESE—Award of five contracts for a total of 23,500 long tons of manganese ore, under the Strategic Materials Act, was announced by the Procurement Division, May 23, as follows:

Boulder Dam Manganese Corporation, Las Vegas, Nev., 5,000 tons of Grade A ore, 62c. per unit of Mn, f.o.b. cars Ogden, Utah.

Western Alloys, Inc., 2,500 tons Grade A, 61c. per unit, f.o.b. cars, Ogden, Utah.

Base Metals Corporation of America, Baltimore, Md., 6,500 tons Grade B, 69c. per unit, c.i.f. Baltimore.

Derivatives, Inc., and Tonerde, Inc., New York, 7,000 tons Grade B, 57c. per unit, c.i.f. Baltimore.

Cuban Mineral Products, Inc., Havana, 2,500 tons Grade C, 64c. per unit, f.o.b. cars, Curtis Bay, Md.

▶ZINC—The March, April, and May statistics of the American Zinc Institute, covering all grades, are summarized as follows in tons:

	March	April	May
Stock at beginning	67,086	73,611	81,234
Production	57,620	54,601	52,979
Production daily rate	1,859	1,820	1,709
Shipments	51,095(a)	46,978(b)	59,177
Unfilled orders	34,580	45,326	55,417
Stock at end	73,611	81,234	75,036

(a) Includes 386 tons exported.
(b) Includes 3,908 tons exported.

Figures covering operations of the Prime Western division, for March, April and May follow:

	March	April	May
Stock at beginning	28,484	32,179	35,258
Production	25,103	22,962	21,487
Shipments	21,408	19,883	25,038
Stock at end	32,179	35,258	31,707

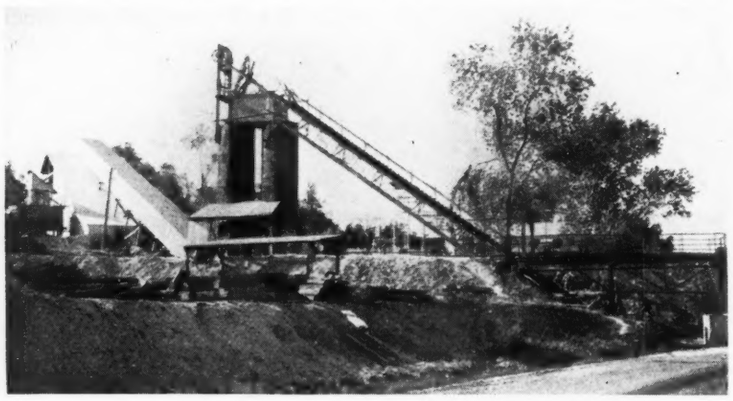
▶CHROME—The Procurement Division of the Treasury awarded a contract on May 9 to E. J. Lavino & Company, Philadelphia, Pa., for 7,000 tons of chrome ore at $24 per ton. On June 1 the company also was awarded the contract for 12,500 long tons of chrome ore at $24.50 per ton.

▶QUICKSILVER—Domestic production of quicksilver during 1939 amounted to 18,633 flasks, the highest recorded since 1931, but only 10 per cent above the average for the five-year period 1934-38, according to the final estimate of the Bureau of Mines, Department of the Interior.

Production of quicksilver in the years 1939 and 1938, in flasks of 76 pounds each, was as follows:

1939	Producing Mines	Output, Flasks
California	59	11,127
Nevada	25	828
Oregon	14	4,592
Other States (a)	9	2,086
Totals	107	18,633
1938		
California	52	12,277
Nevada	17	336
Oregon	13	4,610
Other States (a)	9	768
Totals	91	17,991

(a) Includes Alaska, Arkansas, Texas, and Washington in 1938; Arizona, Arkansas, Idaho, and Texas in 1939.



Headframe and 50-ton pilot mill at the Pennsylvania mine, at Brown's Valley, Calif., operated by Empire Star Mines Company, Ltd. Shaft sinking and other mine development are now in progress, ore being treated in the small mill

CALIFORNIA

Cyanide Plant Being Erected at Lava Cap Mine

Tailings and middlings from flotation to be treated in new mill—Stockton Hill Corporation acquires Erin-Go-Bragh mine—Abbott quicksilver property being rehabilitated

▶ Lava Cap Gold Mining Corporation, at Nevada City, is constructing a cyanide plant for treating 400 tons of tailings per day as well as middlings from its flotation plant. The plant is expected to be in operation by Aug. 1. Provisions are also being made for treating all of the Company's concentrates from its flotation plant. Sinking the main shaft at the Central mine from the 12 to 14th level, a distance of 400 ft., was completed early in June. About 330 men are employed. Otto E. Schiffner is vice-president and general manager.

▶ The surface plant at the Erin-Go-Bragh mine, including the 125-ton flotation mill, once operated by the now bankrupt Delgold Corporation, has been acquired by the Stockton Hill Corporation, W. R. Wook, president. All units will be transported to and re-erected at the Stockton Hill mine near Auburn.

▶ Rehabilitation work has been started at the Abbott quicksilver mine, near Wilbur Springs, Lake County, acquired recently by Mark Ewald, of Olympia, Wash., and associates. Current activities are centered in reconditioning the 700-ft. tunnel that affords access to old underground workings. P. W. Racey, of Vancouver, B. C., is consulting engineer.

▶ F. A. Rogers, of Temple City, and F. B. Smith, of Los Angeles, have obtained a five-year lease on the Nez Perce lode mining claims in the Silver Mountain mining area about 14 miles north west of Victorville, San Bernardino County, from E. P. McCann, Los Angeles. The contract calls for 15 per cent of monthly ore production returns, and operations are scheduled to commence at an early date.

▶ A lease arrangement requiring complete equipment of the Kanaka Hill hydraulic mine, near Happy Camp, Siskiyou County, including construction of a surface plant, cable bridge across the Klamath River, flume, and installation of hydraulic machinery, by next November, has been concluded between K. M. Scoville, of Oakland, and Steve Green, the owner. The property is estimated to contain some 3,000,000 cu.-yd. of gold-bearing gravel. Preliminary work is to start early in June.

▶ Flotation equipment is being installed at the concentrator of Carson Hill Gold Corporation, operating extensive mineral holdings at Melones, Calaveras County. Current production exceeds 1,100 tons per day, which is obtained both from open-pit and underground operations. Work is directed by John A. Burgess.

▶ A two-compartment shaft is being sunk at the Lucky L mine, near Susanville, to a depth of 200 ft., to develop parallel veins dipping toward each other. Ore now being removed is being accumulated for treatment, awaiting the completion of a custum mill under construction near Susanville. Preliminary stripping operations on the north vein recently revealed high-grade ore near the surface for approximately 200 ft. Bernard P. Lackey, Box 531, Susanville, Calif., is directing operations.

▶ Preliminary test work preparatory to opening a new mine on the noted Central Hill gravel channel between Angels Camp and Vallecito, Calaveras County, has started under the direction of R. R. Woolley and associates, of Los Angeles, who until a short time ago operated the Golden River property in the same area. Other gravel mines situated on the channel are the Calaveras Central, Vallecito Western, Slab Ranch, and Altaville, all a short distance from Angels Camp. The latter two have recently been reopened, and rehabilitation of surface plants is in progress.

▶ Shut down for several months because of adverse weather conditions, mining operations have been resumed at the Mary Jane mine, above Fuller Lake, Nevada County. Current work includes cleaning out the 1,176-ft. tunnel, of which about 600 ft. have been completed. Robert Beck is in charge.

▶ Following completion of extensive test work, the Lincoln Gold Dredging Company has moved its dragline dredging equipment from French Gulch to new ground near Lewiston, Trinity County, adjacent to the area formerly worked by the Gold Bar Dredging Company.

▶ The Panob Dredging Company has placed in operation a Judson-Pacific dry-land dragline plant on the James Walkup property, near Lincoln, Placer County. Working equipment consists of a 1¼-yd. Northwest dragline and a washing plant with six Ainlay bowls mounted on tracks. The company is headed by Walter Pantle and C. L. O'Brien, of Sacramento.

▶ Eastern interests represented by Norman L. Wimmler, San Francisco consulting engineer, are operating dragline dredging equipment at Forks of Salmon, Siskiyou County. Increased activities pending completion of test work, including consideration of hydraulic mining, are planned.

▶ The Port Arthur mine, near Angels Camp, is scheduled to be reopened soon, with Joe Hamby in charge. Operations were suspended about fifteen years ago, and development consists of a 120-ft. shaft. Installation of mining equipment is in progress.

▶ Construction of a power line from Monticello, Napa County, to the Knoxville quicksilver mine, operated by the Gamble and Wilson interests, is nearing completion. Additional development work planned preparatory to actual exploitation includes unwatering the old Redington shaft. Operations are directed by T. S. Scribner, superintendent.

ARIZONA

Small Mine Operators Seek Class C Loans

Passage of Senate bill would permit Reconstruction Finance Corporation allotments of $5,000 for small properties of merit—Lack of profitable ore at Montana mine forces closing of property

▶ The Arizona Small Mine Operators Association is seeking to obtain passage of a bill in Washington covering Class C mining loans. The bill, S. 4013, authorizes loans not to exceed $5,000 to develop prospects of probable merit; unwater old workings; retimber and sample old mines; repair and construct roads to mines; and to purchase equipment for development. The bill states that loans may be made to facilitate production of commercial or strategic metals or minerals. The RFC is authorized to withhold unexpended portion of loan and cancel loans if it determines further expenditures uneconomic. The interest rate would be 4 per cent and RFC will take as security a first lien upon all ore or metal in the property, payable in royalty of 15 per cent of net smelter, mill, or mint returns. Title to equipment purchased will remain in the RFC until the loan is repaid. The money to be provided for this bill will be by Treasury issuance of silver certificates

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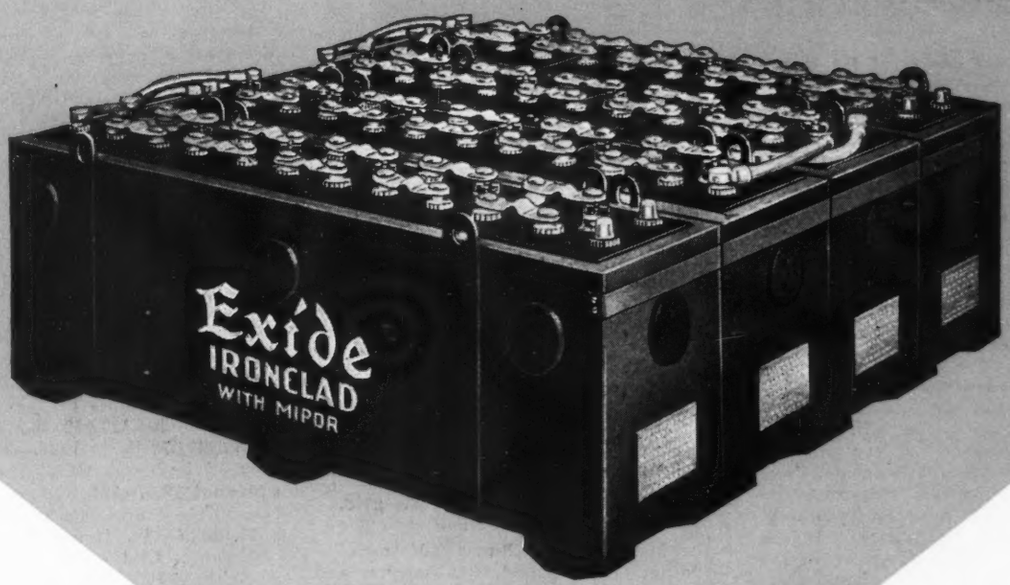

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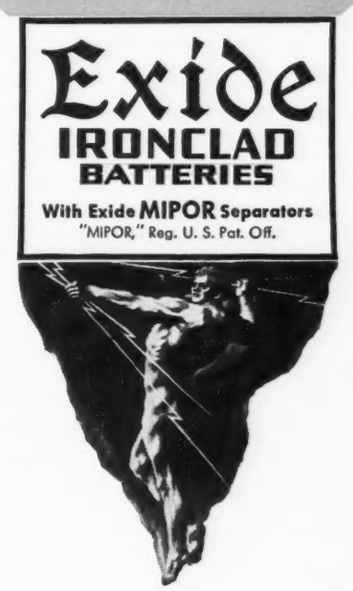

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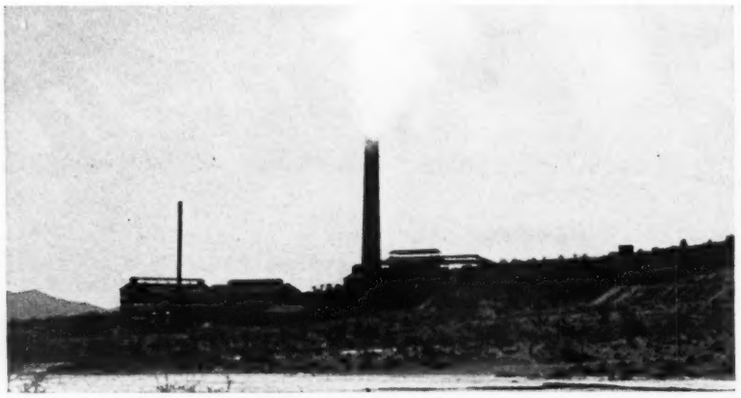

The copper smelter of the Magma Copper Company at Superior, Ariz., shown above recovers the copper, gold, and silver produced at the company's mines, but the zinc ore from the Magma mine is concentrated at the company mill and shipped to a zinc smelter

▶ARIZONA

against 45 per cent seigniorage collected on domestic silver production subsequent to July 1, 1939. The RFC may make use of any State agency created for the purpose of encouraging the development of mineral resources and pay such State agency for services rendered. Senators McCarran, of Nevada, and Ashurst, of Arizona, introduced the bill. W. J. Graham is president of the Arizona Small Mine Operators Association. Passage of this bill would encourage development of small mineral deposits in most of the Western States. A bill, S. 4008, was introduced recently in the Senate to expand Class B loans from present provisions permitting $20,000 maximum on deposits containing gold, silver, or tin, to a maximum of $40,000. Observers believe rapid action is expected on this bill, with a good possibility for passage in the present session.

▶The Montana lead-zinc mine of the Eagle-Picher Mining & Smelting Company, at Ruby, Ariz., discontinued operations permanently on May 16 because of insufficient ore. The last mining was confined above the 400 level with some oxidized ore recovered from the 100 level. The company also cleaned up many dumps and undertook sinking a prospect shaft at the adjoining Hanson and Miller property. E. Morton was manager of operations.

▶A 40 ton mill was recently completed and initial operations were started at the Blue Bird mine, near Copper Creek, Pinal County, to treat gold ore. High-grade ore will be shipped directly to the smelter at El Paso. Frank Fields is general manager.

▶New equipment is being added to the mill of the Vivian Mining Company three miles west of Oatman, in Mohave County, and is being remodeled into an all-slime, countercurrent cyanidation plant with a daily capacity of 125 tons. It is expected that the remodeling will be completed in June. Three 30x12 ft. Dorr thickeners were recently installed. T. S. Davey is general manager.

▶The Alto gold property, in the Oatman district, is being operated under lease by Tex Ingram. Considerable ore has been taken from this mine in prior years and treated at the Tom Reed and the Vivian mills.

▶The Grand Prize gold mine, in the Cottonwood district, east of Florence, was recently optioned by F. C. Merrell from its owner, Charles Miemeyer, of Florence.

▶The Troxel mine, in the Mineral Mountain district, was recently taken under option by a group of California men. Mine development is reported to be sufficiently encouraging to proceed with plans for a flotation plant of around 100 tons' capacity to treat the gold, copper, silver, and lead ore.

▶On May 27 the Douglas Memorial Building for mines and metallurgy was dedicated at the University of Arizona, Tucson. The building is a gift of the Phelps Dodge Corporation in memory of Dr. James Douglas, founder of the corporation and pioneer in mining development in Arizona. A symposium on mining in Arizona was presented prior to the public ceremony.

MONTANA

Hecla Mining Company Prospecting Near Norris

Property of Helene Mining Company being investigated—Domestic output of copper by Anaconda Copper Mining Company totaled 200,417,863 lb. in 1939

▶An option for the purchase of control of the stock of Helene Mining Company is being held by the Hecla Mining Company. This property is about three miles east of Norris, Mont. It has recently received attention on account of the favorable development of the Boaz mine, which is located near the Helene. The company is sinking a winze from the 80-ft. level, and intends to sink 200 ft., from which level a vein that produced some gold near the surface and two other veins that merit attention will be prospected.

▶The total output of copper by the plants of the Anaconda Copper Mining Company and its subsidiaries in 1939 aggregated 934,587,689 lb. The metallic copper production, after deduction of 175,013 lb. (of which 127,438 lb. was from company mines) contained in byproduct materials sold to others, was 934,412,676 lb., obtained from the following sources: 203,216,783 lb. as treated on toll for the account of others; 49,783,474 lb. was produced from purchased ores, concentrates, and secondary metals; leaving a net production from the mines of the company and its consolidated subsidiary mining companies through copper plant operations of 681,412,419 lb. (200,417,863 lb. domestic and 480,994,556 lb. foreign), compared with 633,671,825 lb. (154,208,961 lb. domestic and 479,462,864 lb. foreign) in 1938, an increase of 7.5 per cent. Total deliveries in both the domestic and foreign markets of copper from all sources, including purchased copper, amounted to 883,235,702 lb., compared with 790,083,357 lb. in 1938. Total zinc production was 224,056,850 lb., of which 141,693,675 lb. was from purchased material; toll zinc returnable 60,285,317 lb., and 22,077,858 lb. from the mines of the company. Of total production 7,955 lb. was contained in byproduct materials sold to other companies; 6,732,164 lb. was in the form of zinc dross, and 217,316,731 lb. was electrolytic zinc produced by the plants of the company. Deliveries of zinc (produced and purchased) including zinc delivered to the manufacturing and zinc oxide plants of the company, amounted to 201,127,612 lb., compared with 150,393,070 lb. in 1938. Total production of lead was 90,663,398 lb. Of this amount 79,476,853 lb. was produced from purchased ores, concentrates, etc., and 11,186,545 lb. from the mines of the company. Of the aggregate production, 25,523,450 lb. was included in byproducts sold to other companies and 65,139,948 lb. was produced in metallic form by the plants of the company. Deliveries of lead during the year, including that used in the manufacture of white lead, were 83,577,841 lb., compared with 60,820,021 lb. in 1938. The company produced 14,572,530 oz. of silver, of which 866,480 oz. was treated on toll for account of others, 6,855,912 oz. was produced from purchased ores and concentrates, and 6,860,138 oz. was produced from company ores. Of the total 2,052,717 oz. was contained in byproduct materials sold to other companies. Gold production amounted to 245,993 oz., of which 40,432 oz. was contained in materials treated on toll for the account of others, 165,086 oz. came from purchased materials, and 40,475 oz. from the mines of the company. Of this amount 8,641 oz. was sold in the form of various byproduct materials to other companies. The principal miscellaneous products consisted of 89,775,271 ft. of lumber, 57,205 tons treble-superphosphate and phosphoric acid; 8,709 tons arsenic; 986,304 lb. cadmium, including 159,537 lb. produced on toll.

▶A new lower-tunnel development is being driven on the Mapleton property, near Virginia City, by Mapleton Gold Mines, Inc., under the direction of W. J. Franklin. About 625 ft. of the 1,000-ft. objective has been completed since the company started work about a year ago. During this time 71 cars of gold ore have been shipped.

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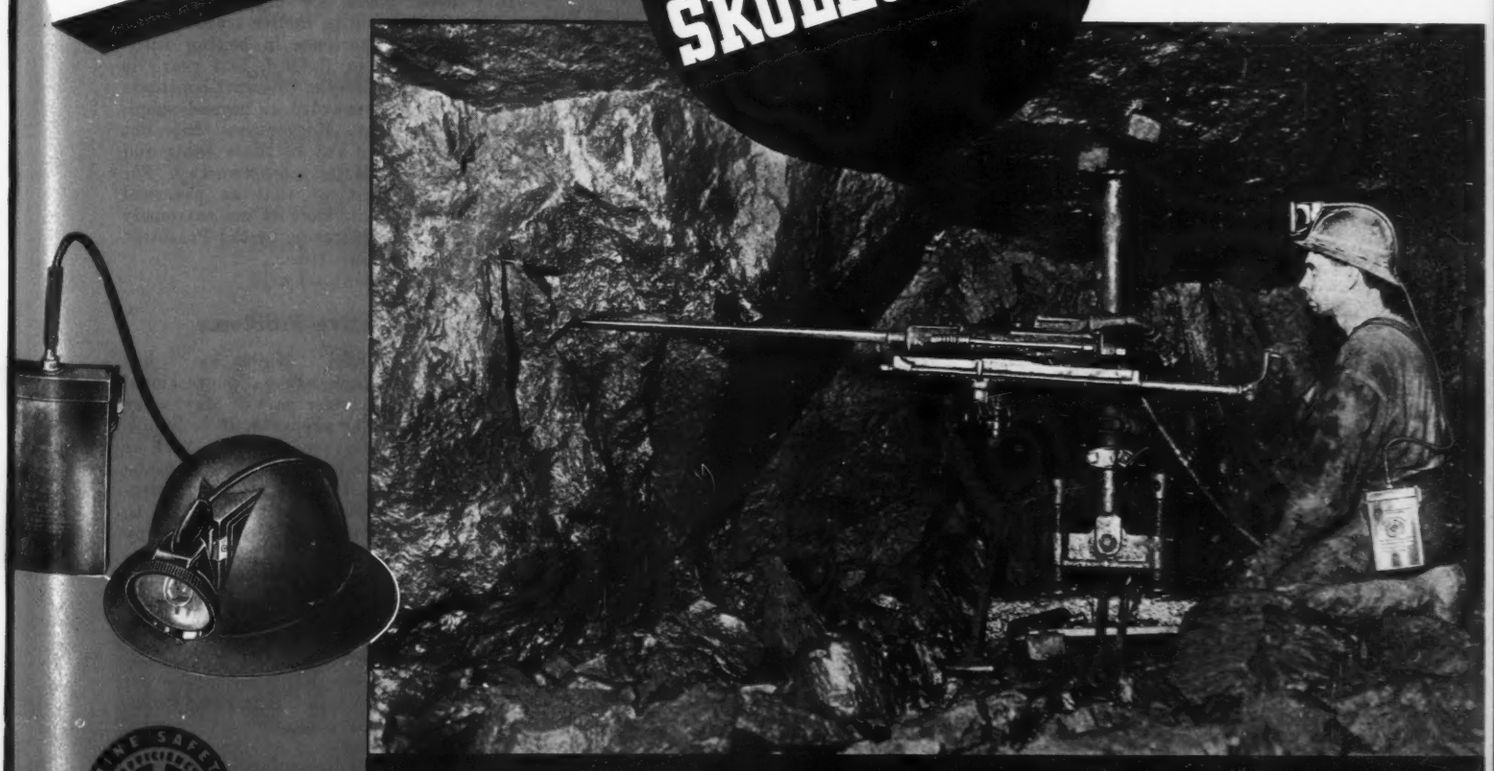

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NEWS FROM Washington

By Special Correspondent

BIG SPENDING WILL COME. This appears to be the one sure forecast in Washington during late May. Preparedness is, of course, the prime objective. But it is not the only one. Even the sincere efforts of Congressmen and executive department leaders to do a good job for the protection of the United States cannot remain uncontaminated by thought of the political advantage which this spending gives to those now in official position.

The economy program and its advocates are as badly routed as the armies of any of the small neutral nations of Europe which Mr. Hitler has arranged to "protect." All budget planning was at first forgotten, and despite the unanimous and enthusiastic avoidance of new taxes, the national debt limit was being ignored. This would have postponed until after election the problem of what to do when funds and credit needed for big spending can no longer be had within the $45,000,000,000 limit. But late in May, Congress and the President decided that despite elections, it was safe both to levy new taxes and to raise the debt limit.

A Billion for Strategics

THE ABSURD EXTREMES reached in talk lately are illustrated by the problems of preparedness which have greatest interest for the mining and metal industries. This interest, of course, centers on the buying of strategic minerals, of which tin, manganese, chromium, and tungsten are most important. As reported last month in *E.&M.J.*, the funds available for the coming fiscal year were to be $12,500,000, of which $3,000,000 was to be committed by immediate contract actions. Promptly following the President's message to Congress regarding preparedness, another $12,500,000 was added to this fund, and before that plan could get out of committee, still another $35,000,000 was requested for the program. Thus metal and mineral spending for the stockpile will probably involve about $60,000,000 during the coming twelve months. However, there are pending at the end of May still other bills appropriating $100,000,000 and authorizing a like amount in contracts for Army and Navy use.

There is a big "if," however. It is caused by the uncertainty as to whether Uncle Sam can actually get anyone to produce and bring to our shores the desired quality and quantity of metals and minerals to use this much money. Transport is the main problem in some cases. But the availability of tin hinges on the Netherland East Indies situation. And the British close control of their colonial supplies of chromium and manganese suggests uncertainty as to whether wanted quantities of those important strategic ores can be diverted from the Gold Coast and other sources to American use.

Three other plans for spending to procure strategic materials are being talked. It is discovered that the RFC has authority both to negotiate for the purchase abroad of strategic materials, and to loan industry the money to make such purchases. Early discussion of the use of that authority mentioned $300,000,000 and $500,000,000 as possible amounts. Agricultural leaders are anxious that they too be given authority to trade surpluses of agricultural products for more supplies of wanted strategic materials. They talk in terms of an additional authority of half a billion dollars. Of course, both Agriculture and RFC would presumably deal more with rubber, manila, fiber, silk, and other agricultural strategies than with minerals.

This all adds up to about a billion dollars in the current talk of Washington. That is not such a silly figure as it might seem. A year ago official estimates at peace-time price levels indicated that needed strategic material stocks would have then cost over $750,000,000. At present prices, a billion would not build the stocks which the Army and Navy would like to have within the United States. But it is not at all clear that anything approaching a billion will be spent. Certainly the $60,000,000 indicated in the foregoing, which will go largely for metals and minerals, is about all that the mining industry will find of direct concern.

Preparedness Officials

ALMOST DAILY during the latter part of May there were radical changes in the "plans definitely decided on" for organizing the preparedness program. Even those sitting almost at the President's elbow hardly can tell how changing suggestion, matured consideration, or new political influences may make necessary radical shift in policy.

One day it was a new War Industries Board that was planned. The next day one heard of key personnel named to manage this or that particular technical problem. The range in decisions is all the way from coalition cabinets to exclusive use of career or uniformed agencies. The confusion of May 1940 is no less, perhaps greater, than in April 1917. All of the present phenomena are merely slightly modernistic counterparts of early World War activities. And it is not too sure that the new Council of National Defense will remain long in power.

The President obviously has several times decided that he must have a new Secretary of War, a desire which he has not concealed from the press for several years past. A new Secretary of the Navy is certain, as Mr. Edison is Democratic candidate for Governor of New Jersey. The very real dissatisfaction in Congress with the lack of progress made by the uniformed services has been a strong influence for the naming of an experienced big-business executive to one or both of these posts. The military organizations have not been happy at this thought. They think that they have done all that could be expected with the funds and limited authority given them by Congress.

Hindsight is excellent. It is evident now that all America is demanding immediate progress for defense. When the Senate by rollcall votes of 74 to 0 and 78 to 0 passes Army and Navy appropriation measures providing $3,300,000,000 for the next fiscal year, Washington is no place for pacifists or economizers.

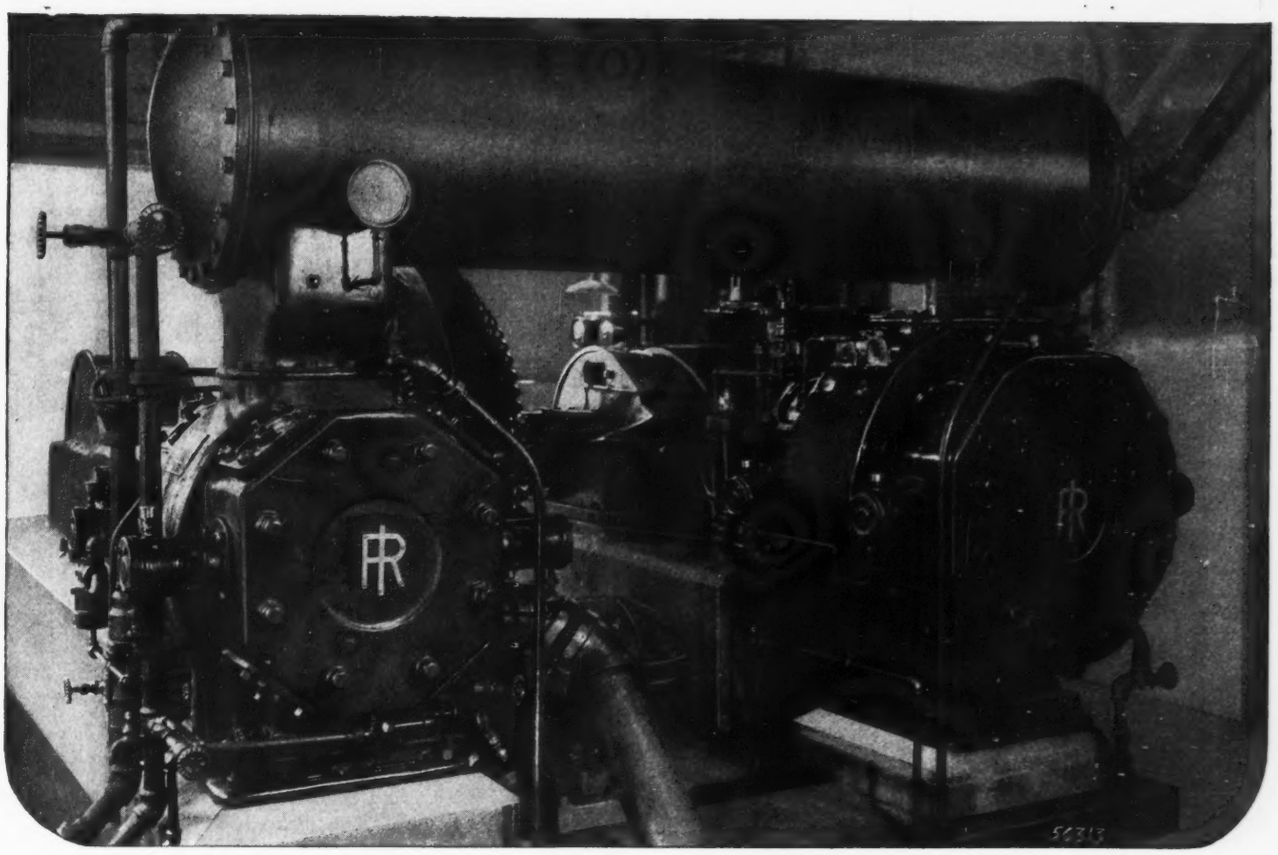
Those officials whose legs are almost long enough to reach the ground have one idea that is perhaps most likely to prevail in the end. Of course, there may be a half dozen false starts at intermediate stages. That idea is that a definite procurement plan for needed raw materials must be set up. The preliminary portions of this plan must be arranged by a combination of technical men (like economic geologists) and business men who know the trades through which the goods must flow. They believe that some procurement official will ultimately be named to head the mineral- and metal-buying plans. In the latter part of May it looks as though that official will be technically an assistant to the Secretary of the Treasury, working also in cooperation with Mr. Stettinius.

Washington believes that Secretary Morgenthau has been made, in effect, chief procurement official. As the titular head of the Procurement Division of the Treasury Department, this would be logical. But actually the cause is believed by many to be the seeping out from military departments of highly unsavory odors originating in earlier transactions. The Navy's experience in buying tungsten (reported in *E.&M.J.* last year) is but one such example. Aircraft contracts have not been regarded as beyond suspicion. Secretary Morgenthau has not been involved in any of those cases and is believed to be fully trustworthy. For political reasons, as well as practical good government, that is an extremely important consideration to the President at this particular time.

Legislative Problems

PREPAREDNESS legislation has smothered much other Congressional activity. In the latter part of May, when this copy must be prepared, it is impossible to tell whether Congress will be able to extricate many important measures from this tangle before adjournment. This adjournment was planned to take place by mid-June, before this copy can reach the readers of *E.&M.J.* Detailed interpretations are, therefore, out of place until next month. However, a few comments on accomplished facts are worth while.

Silver buying from foreign sources would be stopped under a bill passed by the Senate. But this bill is being interpreted as revenue legislation. Therefore, critics think that the bill should have originated in the House. Speaker Bankhead for some time held the bill without reference to committee, and later it was returned to the Senate. This is a part



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of the Administration strategy to smother this legislation. (See *E.&M.J.*, May issue, p. 72.)

The Hatch clean-politics bill is publicly approved but privately opposed by many incumbent legislators. They fear that many of their home State machines will be seriously impaired by the legislation. It forbids political activity of State or local employees who are paid partly or even indirectly from Federal funds. It was good politics, though unexpected, that the President recommended enactment this year.

Provision for requirement of court review of administrative policies and decisions, the Walter-Logan bill, will undoubtedly pass the Senate, if it can be forced up for a vote soon enough. The House has already passed it. Talk of a Presidential veto is taken seriously, but some wonder whether the President would venture such a vigorous New Deal action. Veto would antagonize a great many in business, and probably become a significant campaign issue, more harmful to the Democrats than helpful among ultra-progressive groups.

Extra session talk hinges on military developments in Europe. Obviously, the President would not want Congress back in Washington before election. If it should be called back after election, it would be a lame-duck session. At that time it could, of course, carry to completion legislative action left in suspense by June adjournment. The fear of that possibility is probably as strong as any factor in the minds of the New Deal leaders, who are a bit jittery that much of the reform program may suffer a setback if Congress votes its real judgment on pending "reform" issues.

Industrial Ore Stocks

THE RECENT POLICY of the British has been to allot for American consumption only mineral quantities comparable with peace-time American need for ferro-alloys. If the ore supplies continue to be so restricted there is grave danger that the United States reserves in commercial hands will shrink seriously. Some unofficial comment from important government sources indicates a real concern of officialdom. Discussing one such important ferro-alloy ore, which must remain unidentified, such comment indicates that within the first three months of 1940 the stocks on hand declined from the equivalent of twelve months' supply to nine months' supply. This, of course, means that within a relatively few more months of such trend there might be no commercially held reserves available for industrial operations. Army and Navy authorities are as deeply concerned at such a prospect as are industrialists.

One of the methods originally suggested to eliminate shrinkage of stocks was to forbid exports. That policy may be applied in a very small way to restrict under a license plan some exports to Russia, Japan, or other aggressor nations which would still like to buy here. But such restrictions are not important when compared with the outbound movement in manufactured products of strategic materials used by American makers of alloys, metal products, machinery, and equipment. This outbound movement is the basis of newly developing foreign trade, with Latin America for example. Or, it is a part of our effort to help the Allies with needed equipment and materials. Neither of those types of exports will be restricted.

An alternative plan, being talked about, may be seriously considered shortly. It contemplates that the British, French, and other friendly nations will be told that they must let American manufacturers have more mineral raw material promptly. They will be asked to let American industry have at least as much *additional* strategic materials from their colonial sources as is equivalent to the content of strategics included in the Allies' purchases. A certain number of pounds of the important strategic ores would be expected for each automobile or airplane shipped, to cite one simple example. That plan would probably have Allied acceptance if it were formally presented and considered at London or Paris. It, Washington experts believe, is the only mutually acceptable and workable basis for strategics trade.

Sayers, Mines Director

BEFORE he had served more than a few weeks as Acting Director of the Bureau of Mines, Dr. R. R. Sayers was nominated by the President to be the permanent Director. His nomination was sent to the Senate during May and was confirmed on the 27th.

To permit the naming of a commissioned officer of the Public Health Service to this civilian post, special authority was granted by Congress in the Interior Department appropriation bill. That authority named Dr. Sayers specifically, and provided both that he could take the post and accept the civilian salary without loss of his official status and retirement privileges in P.H.S.

The prompt acceptance of the nomination by the Senate made the mining-State Senators pass over the opportunity to demand from Secretary Ickes an explanation of his discharge of Director Finch. Several Senators promised their mining constituents that when the successor was named, they would take occasion to air the whole unsavory action of late December and January. Such criticism of the Secretary was not intended to extend to Dr. Sayers, who has been regarded by Washington spokesmen of the mining industry as an acceptable appointee. Probably only preparedness activities could have so overshadowed personnel questions as to eliminate any investigation of the Finch case.

American Tin Smelting?

TWO PLANS by which America might acquire a much-needed protection on tin are being talked in Washington. One of these assumes the very simple procedure of having the United States supply the money, for example by RFC loan, to those who would build new facilities or rebuild old non-ferrous smelting equipment for tin smelting. Such plan would assume that the government was sufficiently interested in tin supply to warrant active participation by ownership, if not by operation, of such facilities.

The second plan assumes that the Dutch, now prevented from smelting in Holland, are desirous of establishing new industrial connections and that they could profitably cooperate with the United States Government or citizens. The subsidy to any such joint undertaking of Dutch and American sponsors could be given very simply by a contract from the government to take a substantial part of the tin so produced for the American stockpile. There is ample surplus of tin concentrates in the Far East, so that large quantities could be brought to the United States. Dutch ships are available. It would be, Washington observers believe, an advantage to the Dutch groups to have an American smelter outlet at their disposal, if not partly under their control.

Even some who have bitterly opposed American exploitation of tin smelting based on Bolivian ores are now talking of the need of cooperation. They realize that we might not get the maximum of technical efficiency nor the lowest cost. But they still think that tin at almost any price is so important as to warrant somewhat uneconomic procedures.

New Machine Warfare

MECHANIZED military technics have changed tremendously the importance of minerals. Formerly one provided a soldier with a uniform, a knapsack, a gun, and a few other accessories. Now such a soldier must have either a tank, an armored car, or some other death-dealing or protective mechanism, or he is not an effective fighting unit. The ratio of manpower to machine power in the field has declined with unbelievable rapidity. The relative importance of metal has gone up correspondingly.

Formerly the objective was to give the greatest possible ratio of horsepower to weight in aircraft. Now, heavy resistant armor and young cannon as offensive weapons are assumed for even high speed, highly mobile aircraft. Here again the material weight per man has been multiplied several fold. All of this increases the demand for strategic materials of the mineral class. This in large measure accounts for the tremendous emphasis being given by the President and Congress to strategic materials planning.

A secondary interpretation of modern, long-range, high-speed warfare also affects mineral supply. Take one simple example. "A single large bomber could practically demolish the world's source of nickel at Sudbury." This, in effect, is another newly accepted philosophy for Washington. It means that materials formerly thought surely available to Uncle Sam are no longer certainly safe against interruption of supply. Washington is thinking in this new way and talking about the necessity for long-range planning in terms quite different than those ever before accepted outside the realm of fantasy or nightmare.

Clear understanding of these ideas seems quite significant for those of the mining and mineral industries who must make industrial decisions interlocked with official (political) decisions of Washington. And the example used (nickel) is probably more typical than exceptional as to the way in which business activity may find itself enmeshed in official planning.

Here's What Happens—

—when a NEW customer tries S-D "Floater" Ball Bearing Wheels

Here's a typical S-D "Floater" Wheel success story. This one is written by a leading mining firm from way down in the Philippine Islands. Previous use of other wheels had been unsatisfactory . . . they could not take the punishment . . . ability to take care of unusual side thrusts was important. This firm asked for quotation on a large quantity of trucks, but due to drastic requirements, we suggested that one set only be shipped for trial and proof of satisfaction. These three letters tell what happened— .

1st Letter

August 16, 1938

Sanford-Day Iron Works,
Knoxville, Tenn.

Gentlemen:

Your advertisement in the Engineering and Mining Journal caught my eye and I am writing for further details on your mine car axle and wheels. So far I have been unable to find a satisfactory wheel and axle assembly. Perhaps you have it. Will you send me cut of your wheel and bearing showing your method of taking care of side thrust? Etc.-Etc.-

October 19, 1938—One set of S-D "Floater" Ball Bearing Wheel trucks ordered for trial.

2nd Letter

March 3, 1939

Sanford-Day Iron Works,
Knoxville, Tenn.

Gentlemen:

This will advise you that we have had your set of trucks in service for about one month. Its performance for that short time has pleased me so much that I am giving you an order at this time for 24 sets. Shipping instructions are the same as for the sample set. Etc.-Etc.-

3rd Letter

April 25, 1940

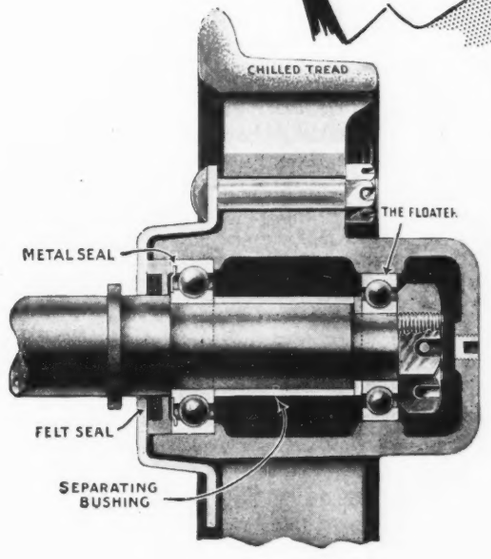
Sanford-Day Iron Works, Inc.,
Knoxville, Tenn.

Gentlemen:

I am very pleased to advise you that the 25 sets of mine car wheels and axles furnished by you, have now been in continuous service for one year and are proving entirely satisfactory. The original grease has not been changed or added to. The bearings of wheels opened for inspection were in perfect condition. You really have the best designed car wheel bearing I have ever run across.

I am not quite ready to place an order for additional car sets but you may rest assured you will get the business when an order is placed.

(Photostatic copies of original letters furnished to interested parties)



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Send me complete details on S-D "Floater" Ball Bearing Wheels, and your FREE TRIAL TRUCK OFFER.

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A Laughlin drop forged Safety Clip takes hold of wire rope with a sure, solid grip — just like a fist. It's no rope crimping "finger pinch," but a rugged vise-like hold. Tests have proved Laughlin Safety Clips twice as efficient as ordinary "finger pinch" U-Bolt clips.

SAVES WIRE ROPE. There's no bowing or distortion of wire strands in rope secured with Laughlin Safety Clips. So — no wire has to be discarded after Safety Clips are removed — with a resultant saving to you.

FASTER TO APPLY. Laughlin Safety Clip nuts are on opposite sides — easy to get at. Two wrenches can be used at once — you save lots of time clipping rope this *modern* way.

Write for free booklet describing many money-saving features of Laughlin safety clips. Also gives results of recent tests by a great engineering school, proving Laughlin Safety Clips 50% more efficient. Fill out coupon — today.

THE THOMAS LAUGHLIN CO.
Portland, Maine

Please send me free Safety Clip booklet. E-5

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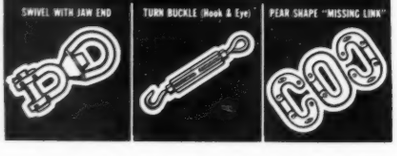

NEVADA

Drilling Program Will Prospect Silver Mines

Property in Eureka County is headed by New York interests — New 250-ton mill planned in Lander County — Rip Van Winkle Mining Company treating 100 tons ore daily in enlarged plant

▶ Diamond drill prospecting is to be undertaken in the famed Cortez group of silver mines in Eureka County, on the Lander County border, according to report. John F. Coleman, 2 Rector St., New York City, is president and John Baldwin is superintendent, receiving mail at Cortez, via Beowawe, Nev.

▶ Early construction of a 250-ton mill, employing jigs and gravity concentration, is planned by a group of Utah men on a property in Lander County, described as lying in Buffalo and Jersey valleys. First mining will be from open cuts by power shovel. Headquarters will be at Battle Mountain. Heads of the project are J. F. Featherstone, of Salt Lake City, vice-president and manager; P. A. Mattingly, president.

▶ A flotation mill completed recently by the Rip Van Winkle Mining Company in the Merrimac district, Elko County, with more recent additions, has attained capacity operation at 100 tons per day. High-grade lead-silver concentrate is shipped to a Utah smelter and zinc concentrate to Texas. L. S. Breckon is president and manager.

▶ Following a week's test run on low-grade cinnabar, the lately completed 50-ton Gould rotary furnace plant of Greenan Quicksilver, Inc., in the Bottle Creek district, Humboldt County, was fed some high-grade ore that had accumulated in development, with a resulting recovery of 50 flasks of mercury in a five-hour furnace run, believed to be a new Nevada record. The furnace is now operating on three shifts, treating ore of average mine grade. J. O. Greenan is president, with offices at 206 North Virginia St., Reno, and W. G. Donaldson is directing engineer for the various Greenan enterprises in Nevada.

▶ Following a prolonged and bitter controversy involving management of the Kimberly, Nev., properties of the Consolidated Coppermines Corporation and upon receipt of a report by a special investigating committee, the board of directors, at a meeting in New York on May 6, approved the committee's recommendations, and reinstated J. B. Haffner as general manager, J. A. Richards as superintendent, and Paul J. Sirkegian as assistant superintendent. The office of consulting engineer, held theretofore by Robert D. Hoffman, was abolished and Boudinot Atterbury, president, and Philip J. Carret, vice-president, were placed on leave of absence. Manager Haffner was left to establish the future status of Mark A. Smith, formerly mine foreman and who had been elevated to the position of manager by President Atterbury and Vice-President Carret, when visiting the mines early in March in the absence of Manager Haffner, then in Honolulu. They also had placed Haffner on leave of absence, with pay, and his two assistants. At the annual meeting of stockholders on May 7 and 8 the five three-year-term incumbent directors were re-elected, N. E. LaMond declining to serve. Following this meeting the directors elected Director John A. Payne president, I. W. Burnham, II, vice-president, J. B. Haffner, vice-president and general manager, and E. J. McDonald, secretary and treasurer. A report to stockholders, numbering approximately 7,000, stated that the American Metal Company, Ltd., owns 202,000 shares of Consolidated Coppermine stock. A movement by the Atterbury-Carret faction to increase the number of directors, now fifteen, was defeated.

▶ Tungsten Minerals, Inc., a Utah corporation recently organized by Salt Lake and Ogden men, reports that it will start milling operations at its Regan mining district property in White Pine County, Nev. Ore assaying 3.54 per cent tungsten was recently uncovered in the main tunnel.

▶ Shipments have been resumed from the Nelson mine, on California Hill, 2 miles east of Mountain City, Nev., reports Jean R. Driggs, of Salt Lake City, manager of the Gold Ensign Mining Company. A winze is to be sunk at a point 800 ft. distant from the portal of the main tunnel.

▶ Operating in the flat terrain below Manhattan Gulch in central Nye County, the bucket-line dredge of the Manhattan Gold Dredging Company, with rated maximum capacity of 14,000 cu.yd. per day, is said to have been handling as much as 18,000 cu.yd. in a day's operation under the management of John James, engineer for the Natomas company, which owns approximately a one-fourth interest in the enterprise. A. La Plant-Choate Manufacturing Company C-104 "Carrimor" motored by a D-H Caterpillar tractor, is employed in stripping.

▶ John Carroll and associates, of Phoenix, Ariz., are developing a cobalt deposit near Goodsprings, Clark County, Nev. Mail address P. O. Box 1349, Las Vegas, Nev.

COLORADO

South Platte Dredging Company Plans Operations

Will undertake own financing, as management decides not to subscribe for R.F.C. loan—Highland Mary expects to start operations soon—New mill planned for Pride of the West property

▶ After gaining an approval of a $750,000 loan from the R.F.C. in Washington, the South Platte Dredging Company decided to reject the loan and government supervision and finance its own dredge and operations at Fairplay. Jefferson J. Doolittle, of San Francisco, is president, and R. W. Derby, of LaGrange, Calif., manager.

▶ Joseph M. Bradley is rehabilitating the Highland Mary property at the head of Cunningham Gulch near Howardsville. Machinery is being installed

and construction for the new 100 ton mill is under way.

▶The Pride of the West, at Silverton, has been taken over by the Denver Equipment Company, and a new mill is to be erected. Fred A. Brinker, formerly consulting metallurgist for the Shenandoah-Dives Mining Company, manager, states that operations are expected to start during August.

▶A thorough exploration of the Golden Fleece property, on Treasure Mountain, will be made this summer, according to Guy L. V. Emerson, president.

▶The Baxter mine, at Ward, is being rehabilitated after being idle 35 years. C. W. Strong, Jr., of the Bluecoat mine, has obtained lease on the property.

▶The Old Boss Thunderbolt mine, at the head of Rock Creek in the Kellar Mountain-Wilkinson district, near Dillon, has been leased to Marvin Smith, who is working the property through the Fish tunnel. Mr. Smith states he plans erection of a mill within 60 days.

▶Crews driving the Carlton drainage tunnel progressed 1,696 ft. in April, an average of 56.5 ft. per day. This brings the total to 13,695 ft. and it is now estimated they are about 2,200 ft. below the surface.

▶Clear Creek Placers, Inc., operating the largest placer mining unit in the Idaho Springs district, has completed testing 160 acres of the Sternberger estate with a Keystone drill. George Powers, president and general manager, and his associates are now installing a shovel, and a tram connection to the screening plant that is built on a tractor base which will be placed near the edge of the pit.

UTAH

New Bureau of Mines Building Dedicated

Equipment will permit a wide range of research in ore dressing and metallurgy—Continued good development at New Park mine arouses more interest

▶Business, mining, and civic leaders took part in exercises dedicating the new United States Bureau of Mines building on May 20, at the University of Utah, 1,600 East First South Street, Salt Lake City. In the morning, the new $300,000 three-story brick structure, with its laboratory and shops building in the rear, was opened for inspection. In the afternoon, a special dedicatory address was made by Dr. R. R. Sayers, director of the Bureau of Mines; Governor Henry H. Blood; and President George Thomas of the University of Utah. A. G. Mackenzie, executive secretary, Utah Chapter, American Mining Congress, presided. The program was concluded with a banquet at the Hotel Utah in the evening, at which James W. Wade, chairman of the dedicatory program arrangements, presided. Speakers included Dr. A. C. Fieldner, chief of the technologic branch, United States Bureau of Mines; Dr. R. S. Dean, director of the station and chief engineer

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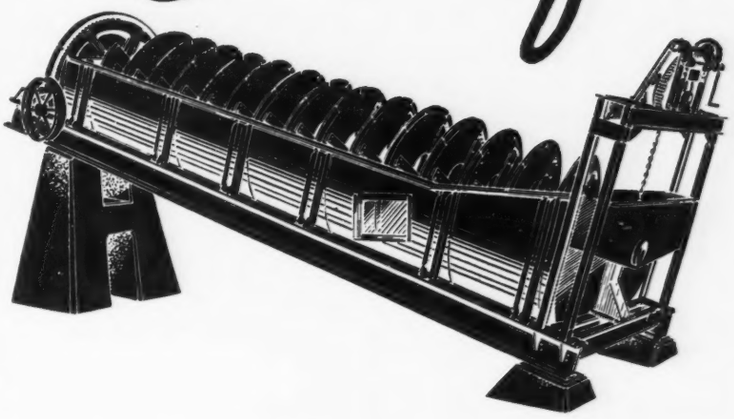

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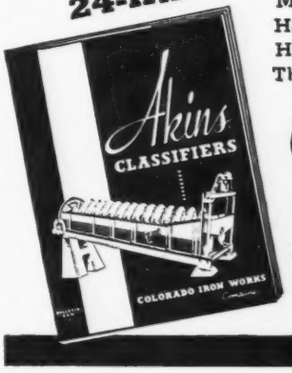

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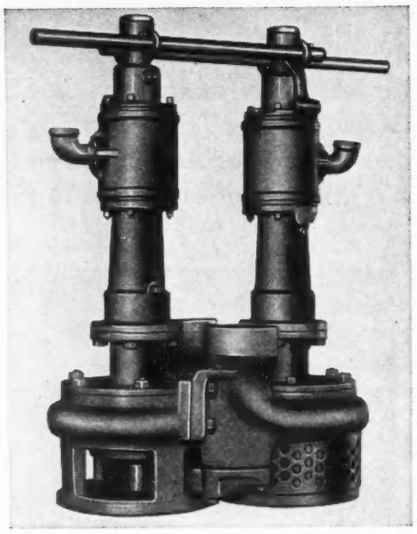
Where lower heads are encountered, the 2-Stage Pneumatic Sponge can be separated, each stage being a complete independent pumping unit, weighing only 85 pounds.



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Intermountain Experiment Station of the Bureau of Mines, Salt Lake City, Utah, was dedicated with appropriate ceremonies on May 20. In addition to ore-dressing equipment, the station is unusually well equipped for experimental metallurgy with respect to high-frequency induction furnaces. The laboratory contains high-frequency power-generating units from 3 kva to 60 kva in which may be melted charges from a few grams to 150 lbs.

▶UTAH

of the metallurgical division; City Attorney E. R. Christensen; Herbert A. Snow, president of the Salt Lake Chamber of Commerce; and Dr. Sayers. D. M. Kelly, of Butte, Mont., vice-president in charge of Western operation, Anaconda Copper Mining Company, who was scheduled to speak, was unable to attend.

▶Increased production and revenues from development of the New Park mine, in the East Park City district, have greatly stimulated activity in this vicinity. W. H. H. Crammer, president and general manager, reports that commercial ore of an average width measuring 7 ft. has been drifted in for over 650 ft. At the last report the ore had widened to 15 ft. Gold content had increased to 0.58 oz. per ton; silver averages 16 oz.; lead ranges from 6 to 10 per cent; and zinc, 3 to 5 per cent. Three 60-ton carloads of ore are being produced daily. Already, there is talk of extending the Union Pacific branch railroad from Keetley to the mine, about 2 miles. The company has purchased a large Mancha locomotive to replace the small unit, new ore cars, and other equipment. The change-room and shops at the mouth of the Mayflower tunnel are being enlarged and a larger compressor is being moved down from the Park Galena property. Clark Wilson has been employed to do surveying and geological work, and R. H. Abbott, of Salt Lake City, as consulting engineer.

▶The Old Hickory mine, operated near Milford by the Prosper Mining Company, is mining copper-gold ore on the surface in an open cut with a power shovel. Leasers are producing steadily ores averaging high in copper and zinc from the Moscow Silver mine. The Honey Boy mine is being reopened after a shutdown since January.

▶Further development work is to be done by the Tintic Gold mine on the 400 level of the Tintic mine. Work will be started north of the shaft and 170 ft. south of the shaft in the Ajax formation. J. J. Beeson is consulting geologist of the company.

▶The Treasure Hill Mines Company, with G. M. Paulson as president, has started work on the Arabella and Thad Stevens claims, leased from the Madison Mines Company near Ophir. An incline is to be sunk from the 150 level of the Madison mine. Contract for this work was awarded to William Diemunsch.

▶The State Tax Commission levied occupation taxes totaling $485,870.06 against Utah metal mines on May 8. This is equal to 1 per cent of gross production during the year 1939. Last year the tax amounted to $320,437.15 and in 1938 to $541,363.64. Of the total amount for 1940, $389,221.91 was charged to Utah Copper Company. The second largest tax payer in this field will be the Bingham and Lark mines of the United States Smelting, Refining and Mining Company, with a total of $25,985.32.

▶Operations have been resumed at the Geyser Marion Gold Mining Company's property at Mercury after a two-week shut-down caused by a labor dispute. Officials of the CIO claimed that the independent union was dominated by the company. An investigator for the NLRB dissolved the independent union. Though operations have been resumed, it is reported that no official bargaining agency for mine and mill employees has yet been determined.

▶Western Alloys, Inc. (Felt Building, Salt Lake City), was awarded on May 23 a bid by the procurement division of the United States Treasury Department to supply 2,500 long tons of Grade A manganese from its property, 19 miles southwest of Valmy, Lander County, Nev. The price was approximately $30 a ton, said J. F. Featherstone, president and general manager of the company. The treasury also awarded a contract for 5,000 tons of Grade A ore to the Boulder Dam Manganese Corporation, Las Vegas, Nev., for $148,000. Western Alloys, Inc., announced Mr. Featherstone, is erecting a mill to handle low-grade manganese ore on its property. Ore in the high-grade deposit of the company assays between 48 and 50 per cent.

IDAHO

Large Gold Dredge Under Construction

Completion is expected during summer for use in Salmon River placer area—Fire damages buildings at Highland-Surprise mine — New mill of Custer Consolidated Mining Company starts operations

▶ The largest gold dredge in the State is being constructed by the Olson Manufacturing Company, of Boise, for use on the Yankee Fork of the Salmon River. It will be completed during the summer.

▶ Highland-Surprise mine, in the Pine Creek district, suffered a $15,000 fire on May 11. The air-compressor building was destroyed along with pumps and other equipment. Fire fighters saved the 200-ton mill after a hard struggle. The mine has been idle for some time, but operations were to be resumed this year if metal prices justified production from the zinc orebody. Dr. Charles R. Mowery, of Spokane, is president and H. M. Huemann, of Wallace, secretary.

▶ Custer Consolidated, operating the Lucky Boy mine, in the Salmon river district, put its new 100-ton ball mill into operation on May 16. Approximately 30 men are employed at the silver-gold property. A. H. Burrows, of Boise, is president.

▶ Charles S. Woodward, of Salt Lake City, president and manager of the Birthday Consolidated Gold Mine, 12 miles east of Lowman, Boise County, Idaho, reports that during the ten-day period ended May 19 four shipments of concentrate and crude ore have been made from the property.

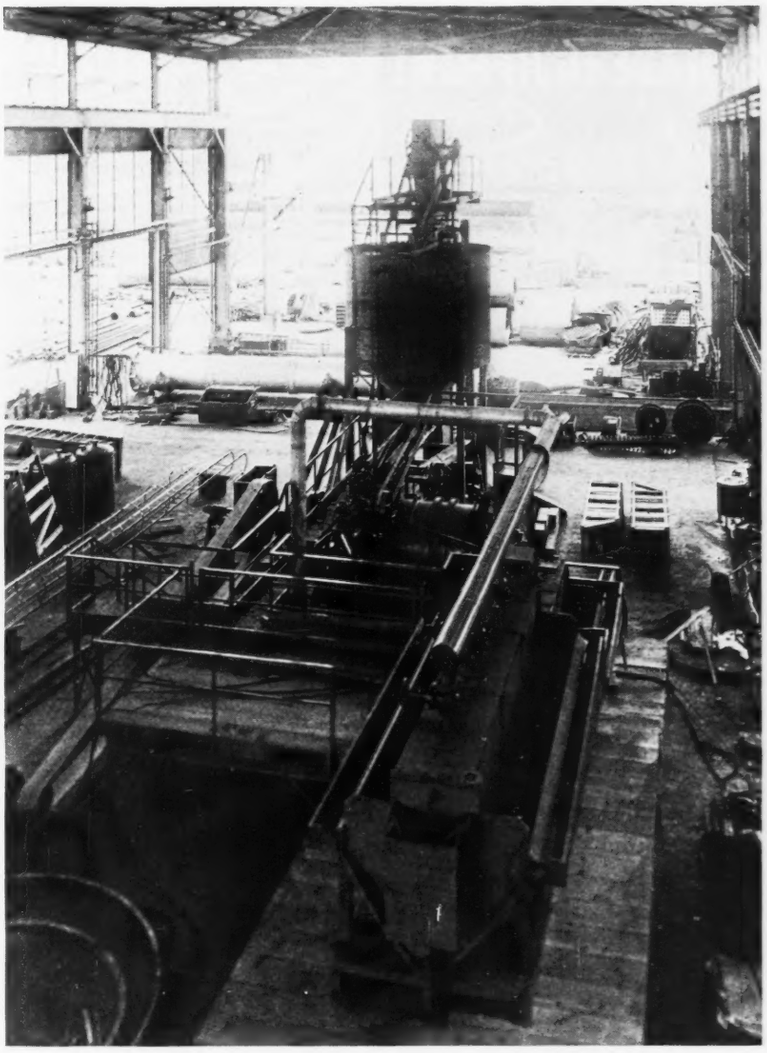
▶ Noon Brothers, dredge operators from Baker, Oregon, announce the purchase of machinery of the Jordan Creek Placer Company and will move the equipment to a new location in Idaho County. Operations are expected to start in July.

▶ Pony Gulch, Murray district, was the scene of a new gold strike by J. D. Chapen, who has been opening the old Kennan gold quartz property. The ore body is 4 ft. wide and will average from $35 to $55 a ton in gold.

▶ Officials of the Coeur d'Alene Mines Corporation report the discovery of a new body of high-grade tetrahedrite silver-copper ore on the 800 level.

▶ Hecla Mining Company has 25 men at work at the Atlas property, near Mullan, completing preliminary operations for the sinking of the 800-ft. three-compartment shaft. A station will be cut on the 400 level and a crosscut driven to the Bird vein. Ralph W. Neyman is general superintendent.

▶ Merger Mines Corporation, operating in the Coeur d'Alene silver belt, have opened the long-sought Portal vein in its long crosscut from the 2,000-ft. level of the Coeur d'Alene Mines shaft. The vein shows 3 to 4 ft. of siderite. Morris Pearson, of Wallace, is president and general manager. The office of the company is 644-645 Peyton Building, Spokane, Wash.



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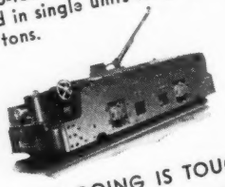

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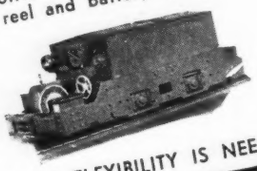

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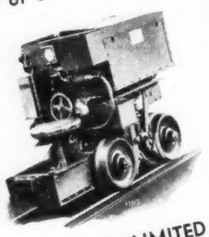

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WASHINGTON

Quicksilver Mine Being Reopened

Mercury Corporation of America plans production this month—Clear Creek Dredging Company begins operations in extensive area

▶ Quicksilver deposits in the Morton district, Lewis County, idle for several years, are attracting interest as the war begins to exert its influence on the mercury market. The Mercury Corporation of America expects to start production toward the end of June from properties it has rehabilitated and equipped in this district. R. C. Rowen is superintendent; Daniel E. Knowles, of New York, president; John W. Southerland, of Chicago, vice-president, and F. E. Pegg, of Seattle, is mining engineer.

▶ Clear Creek Dredging Company, of California, has commenced dredging an extensive area in the Swauk district, near Blewett, on the eastern slope of the Cascades. Included in the 15 miles of creek bottom to be washed is the property of the Swauk Mining & Dredging Company, consisting of 40 mineral claims and 300 acres of patented ground. The company employs a 2¼ cu.yd. diesel-driven dragline with a 60-ft. boom.

▶ Kearney Salt Works, near Oroville, is processing epsom salts and shipping it in carload lots to Kansas City and other Eastern points. C. A. Kearney, proprietor, has recently added an 85-hp. boiler and a 4,500-gal. evaporating plant.

▶ Red Top Mining Company, developing a property in northern Stevens County, near the Canadian line, has driven a tunnel 2,700 ft. and attained a depth of 800 ft. Ore was encountered at 900, 1,000, 1,200, 2,000, 2,100, and 2,400-ft. points. High values in some of the silver-lead oreshoots are reported. S. I. Serigstad, of Minneapolis, is president, and J. Richard Brown, of Spokane, managing director.

▶ In one year, from May 1, 1939, Alder Group Mining Company received smelter returns in excess of $280,000 from the smelter at Tacoma. Of this, all but $25,000 from concentrates came from crude ore. The property is at Twisp, Okanogan County. The mine and mill are operated by Methow Gold Corporation, leasers. Mahlon McCain, of Spokane, is president of the leasing company.

▶ Leonard Hoff and R. E. Crosby, of Spokane, have taken a three-year lease and option on the Farmer lead-silver mine, 14 miles east of Northport.

▶ Columbia Tungsten Corporation has cleared the ground for bin construction at its property in the eastern part of Stevens County. J. M. Arnold, superintendent, reports parallel veins with a total width of about 20 ft. The No. 1 quartz vein contains about 1 per cent tungsten, with some high-grade streaks carrying 5 to 15 per cent tungsten. S. Harry Draper is president.

▶ Industrial Tungsten Corporation, which adjoins the Germania tungsten mine, is completing a mill and expects to be in operation early this summer, according to Ray B. Greene, president. J. E. McCloskey is vice-president and managing director.

▶ Sunrise Mining Company, in northern Stevens County, in the Clugston Creek district, is extending the tunnel to secure an additional 800 ft. of depth, and expects to reach the silver-lead vein soon. John A. Finch is president of this company.

▶ Mule Deer Mining Company is completing a 50-ton mill at its property, east of Ruby, Pend Oreille County. Charles G. Strong, Bremerton, Wash., is president.

ALASKA

Placer Mining Gets Under Way

Equipment and supplies being flown in to several gold placer and lode mining areas

▶ An early spring has encouraged miners in Alaska to view 1940 as a very good year for gold mining. The boats leaving Seattle and San Francisco carry mine operators, investors, prospectors, and a great quantity of mine equipment and supplies, from large dredges down to hand shovels. In addition to gold mining, the United States Geological Survey recently issued an estimated production of 32,000 oz. of platinum this year in the Goodnews Bay District.

▶ Koyukuk Gold Placers, Inc., has flown in from Fairbanks 22,000 lb. of equipment and supplies to the Wiseman camp, north of Fairbanks, and nearly 10,000 lb. are being shipped via river navigation. Fifteen hundred feet of hydraulic pipe, from 16 in. down to 9 in., and a No. 2 giant with a 3-in. nozzle, will be used to strip the ground and wash the gravel. The bedrock is decomposed schist, and the gravel is approximately 35 ft. deep, without large boulders. James Priest, of Fairbanks, is vice-president and manager.

▶ Kugruk Mines, Inc., is adding a new diesel unit at its placer operations at Kugruk River, near Deering, on the north side of Seward Peninsula. A smaller diesel will be used to handle its prospecting drill and for freighting purposes.

▶ Alluvial Golds and Gold Placers, Inc., at Woodchopper and Coal Creek respectively, have started work at its two properties in the Yukon River district. The dredges have been overhauled and fourteen men put to work at the Coal Creek property, where Fred Obermiller is dredgemaster, and 12 men on the Woodchopper property in charge of William Heitman. Ernest N. Patty is head of the company. Another project under Patty's direction known as Canadiun Placers, Ltd., is at Clear Creek, in the Dawson district of the Yukon Territory. William O'Neil was recently at the property starting road construction.

MICHIGAN

Copper Mines Valuation Assessments Lower

Production in 1939 was below that of preceeding four years, due to closing of the Conglomerate mine, which had been operated since 1865

▶A total assessed valuation of $7,331,375 on the copper mining properties of Houghton and Keweenaw counties, including refined copper, was recommended by Franklin G. Pardee, state appraiser of mines, at the annual hearing on mine valuations conducted in Houghton by the State Tax Commission. The 1940 recommendation is a decrease of $206,107 under the 1939 valuation. The hearing was attended by representatives of practically all of the mining companies, active and inactive, in the two counties, and members of the Houghton County Board of Supervisors. Chairman McPherson announced that the commission would take the matter of finally determining the valuations under advisement. In presenting his recommendations to the tax commission, Mr. Pardee said:

The recommended valuations of the Michigan copper mines for 1940 is $7,331,375, which compares with a valuation of $7,537,482 for the same properties for 1939. The production for 1939 was 87,915,153 lb., which was below the figure for the four preceding years. The reason for this drop in production was the closing of the Conglomerate mine on Sept. 30 of last year. During the last few months of operation at the Conglomerate, the mining was confined to only one shaft and the copper that came from this operation last year amounted to only 8,436,000 lb. The closing of the Conglomerate marks the passing of one of the outstanding copper mines of the world operating since 1865. Reworking of the tailings from these early mills has already yielded over a quarter of a billion lb. of copper, which means that the rock that came out of the Conglomerate lode carried over 3,500,000,000 lb. of copper. There has been little change at the other properties other than that occasioned by mining operations, and the recommended valuations are not altered materially from the 1939 figures. Exploration conducted by the Calumet & Hecla in Ontonagon County has been closed down. The new hoist has been installed at the Ahmeek mine and the mine is now prepared to carry mining operations considerably deeper along the lode.

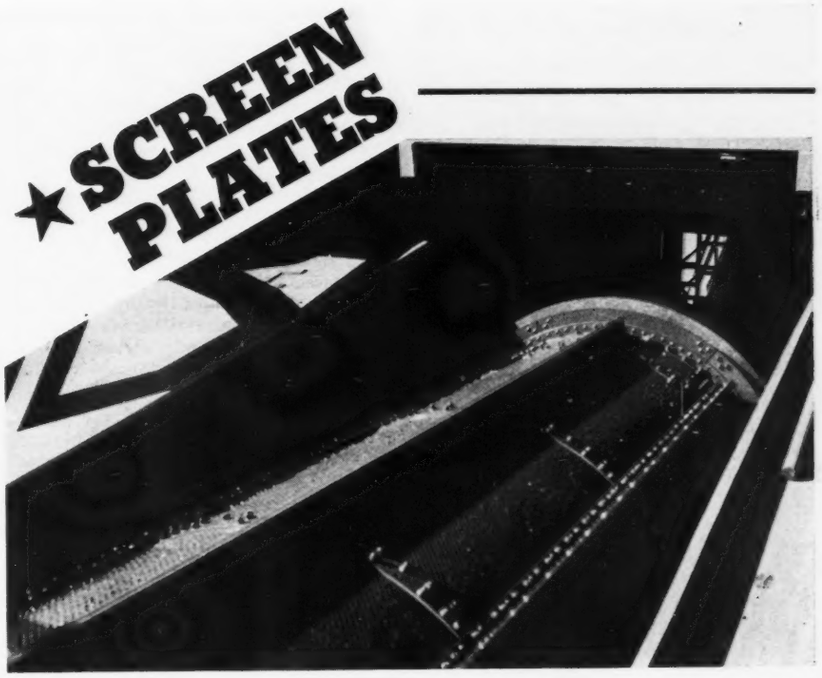
IRON COUNTRY

Activity Increases in Mining Ranges

Prospect for greater production during season looms as steel rate output gains—Progress continues to be made in beneficiation of lower-grade ores

▶Consumption of Lake Superior iron ore at furnaces during April amounted to 3,934,853 tons—slightly less than in March. The balance on hand May 1 amounted to 18,106,151 tons. One hundred and twenty-one furnaces were in blast on April 30 and 68 were idle. This compares with 80 in blast and 109 idle one year ago.

▶All operating companies have started work with increased schedules over those of last year, and if the steel business



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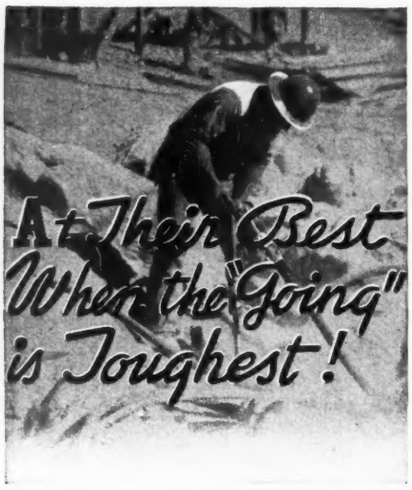

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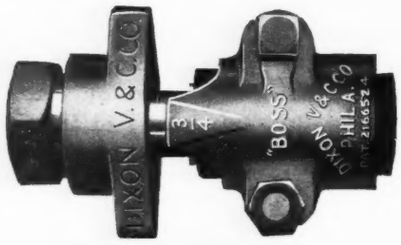

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▶IRON COUNTRY

continues as at present, the iron ore industry should have a very good season. In many of the washing plants new equipment has been installed, and much progress has been made in the method of beneficiation on the Mesaba range.

▶A committee appointed by the last legislature in Minnesota will visit the Minnesota iron ranges on June 21 and will be accompanied by the Tax Commissioner and his assistants. They will make a careful study of the tax set-up and will report their findings at a later date.

▶The senior students of the Colorado School of Mines visited in Hibbing and other points on the Mesaba Range the early part of May.

▶The E. W. Coons Company is opening a small open pit in Virginia, Minn., and will ship a small tonnage of ore this season. The work is being supervised by R. A. Mac Donell, formerly general superintendent for Corrigan-McKinney.

▶Charleson Mining Company has received orders for a tonnage of iron ore and expects to operate the Pacific, at Aurora, and the Judd mine, at Taconite, Minn.

▶Iron ore shipments in May totaled 7,274,024 tons. The largest previous May volume was 10,043,856 tons, in 1937.

TRI-STATE

New Settlement Basis on Concentrates Adopted

Department of Interior approves of new practice as Quapau Indian Agency is involved — Operations increase moderately at some mines

▶Eagle-Picher Mining & Smelting Company has adopted a new settlement basis for production at its Central mill and at least one other property. The Department of the Interior has approved through the Quapaw Indian Agency a set ratio of 6.7 to 1 for zinc concentrate and 12 to 1 for lead concentrate. Engineering and Mining Journal's weekly averages will be used in determining the settlement price on both concentrates. The price per 100 lb. of zinc under the new arrangement will be multiplied by 6.7 to arrive at the base price of 60 per cent zinc concentrate; the factor in establishing the base price of 80 per cent lead concentrate will be 12. Based on the E.&M.J. metal quotations for the week ended May 11, settlement on zinc concentrate was at $38.53 per ton for the week of May 18, and lead concentrate at $58.20 per ton.

▶The Lone Star Mining Company has reopened the Foch mine, a mile west of Picher, Okla. A good deposit of ore has been opened on the 230-ft. level, according to Ed Crossland, of Picher, who is in charge of the operations. The ore is transported two miles by truck to the Central mill of the Eagle-Picher Mining & Smelting Company for treatment.

▶The Semple Mining Company has resumed operations at its Martin tailings re-treatment mill, southeast of Hockerville. The property has been idle since Dec. 24, 1939. Kurt Martin, superintendent, reported that 21 men are employed in the mill and several additional men are employed by Ben Horine, who has the contract for hauling the tailings to the mill.

MEXICO

Coming Elections Create Concern in Industry

Voting on presidential candidates July 7 obscures outlook — Mercury mines in Guerrero may pass into hands of workers

▶Uncertainty as to the outcome of the presidential elections (July 7) is creating an inclination to mark time in the general business outlook until after it has been definitely decided just who will head the Mexican Government, and the resultant effect on the mining industry. Some observers are becoming apprehensive on the political uncertainty that may develop during the summer months. There is an increasing opinion in Mexico that the Townsend bill to suspend purchases of foreign silver by the United States Government will not pass. Those holding to that opinion say that the United States more than ever desires to support Mexico, as well as other Latin American countries economically and otherwise. Loss of the American silver market would be a heavy blow to Mexico.

▶Labor is considered to have an excellent chance of gaining possession of some of America's largest mercury mines, those at Huijucuo, Guerrero, owned by the American-backed Cia. Minera Mercurio de Huijucuo, as no settlement is in sight of the strike for higher pay that started May 5, and the workers may get the property to run cooperatively.

▶Employees of Cia. Minera San Vicente, S.A., San Vicente, Sinaloa, have petitioned the federal government to permit them to take over and operate the properties cooperatively. The workers assert they can run the mines more successfully than the company.

▶The Mexican Government is so convinced that there is soon to be an important revival of mining in the Rincon de Romos and El Cobre sectors, Aguascalientes, where this work stopped some time ago because of depressed market conditions, that it has arranged to condition for regular passenger and freight service the railroad, the Ferrocarril Mexicano de la Union, that served these zones. The line was abandoned some years ago. Its owners have returned the franchise to the government.

▶Increased production for last year was announced by Cia. Minera Los Azules, S. A., Los Azules and Santa Barbara, Chihuahua, Carl Schulze, president. The net 1939 output was 477.171 kg. of gold and 3.927.571 kg. of silver, increases of 54.844 and 1,028.519 kg.,

respectively, over the figures for 1938. Eric Koening and Alexander Genin are new directors, and Otto Strecker and Rodrigo Elcoro are directors.

▶ The Mexican Government has in service six small plants for the treatment of ore mined by prospectors and other independent operators. These plants, the average capacity of each of which is 100 tons, are at Tecamachalco, Federal District; Tlalpujahua, Michoacan; Guanajuato, Guanajuato; and Altar, Nacozari, and Alamos, Sonora. The government has established ore-purchasing agencies at Oaxaca, Oaxaca; Pachuca, Hidalgo; Durango, Durango; Ixtla del Rio, Nayarit; Asientos, Aguascalientes; Mazatlan, Sinaloa; Guadalajara, Jalisco; Iguala, Guerrero, and Santa Ana, Sonora.

▶ Work is being continued on a good scale by the French-owned Cia. del Boleo, S.A., August Nopper, general manager, at its copper mines in the Santa Rosalia sector, Baja California. Production is averaging 800 tons daily, thanks to 3,500 hp. of electricity that is now available. The operating staff consists of P. Mahieux, mine superintendent; J. Geoffroy, mine engineer; R. Reimbert, smelter superintendent; R. Debbaudt, chief clerk; H. Kion, purchasing agent; M. Legeard, master mechanic; P. Perrin, chief electrician; G. Flourie, chief chemist, and Francisco G. Quintanilla, safety inspector.

▶ The United States has a good tungsten source in Mexico from the El Fenomeno mines (also known as the Rosa Castilla mines), ner Ensenada, Baja California, owned by Frederick R. Lee, 4,385 New Jersey St., San Diego, Calif., and H. T. Horton, William Fox Building, Los Angeles. These mines have been running under the present arrangement, since January, 1938.

▶ Miners who were given charge of the Mina de Rincon, Mina Rincon, near Toluca, State of Mexico, last fall as a means of settling a labor conflict, are apparently doing well conducting the property cooperatively. The working force is 800 men, with Col. Charles W. Steinman the chief engineer.

CENTRAL AMERICA

▶ During the first five months of the present fiscal year the production figures of the LaLuz Mines, Ltd., in Nicaragua, Central America, show a total of 54,767 tons ore milled having an average assay of 0.214 oz. gold per ton. Total operating costs per ton for the period October 1930 to February 1940 averaged $2.77. No development work was done in the mine during the period. All ore milled came from old dumps made up of material discarded in previous operations. Two million tons can be mined by open-cut and the pit is being started. During the latter part of the fiscal year it was decided to proceed with the enlargement of the mill to a capacity of 500 to 600 tons, and this work is under way. Construction work is also starting at the Yy River hydroelectric plant. T. Lindsley is president, and Frank Cameron is mine manager.

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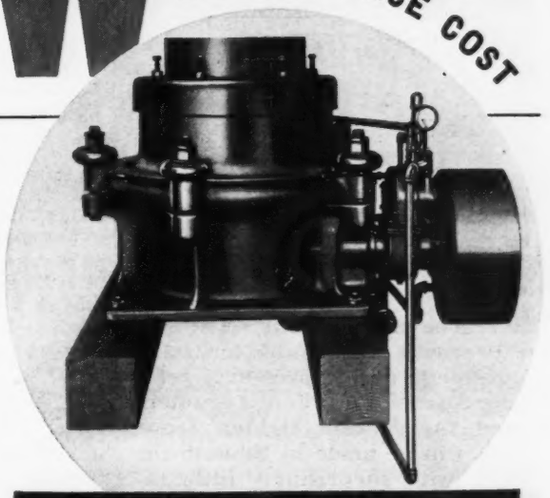
OPERATING COST
MAINTENANCE COST



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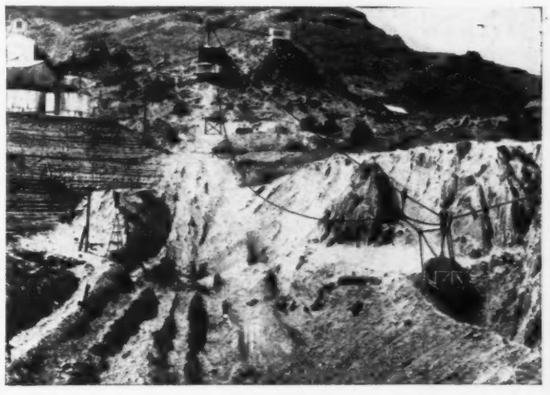

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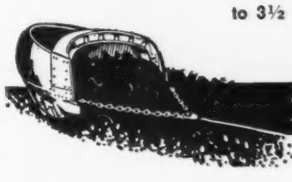

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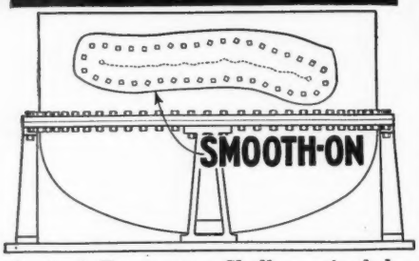

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SOUTH AMERICA

St. John D'el Rey Plans Greater Power Capacity

Construction program also being fulfilled —Plant to recover molybdenum at Braden Copper Company, in Chili, nears completion

▶Gold output from the Morro Velho, Espirito Santo, and Bicalho mines of the St. John D'el Rey Mining Company, Brazil, in 1939 totaled 127,742.11 oz. The tonnage crushed against that of 1938 showed a decrease of 9,800 tons at Morro Velho and an increase of 37,000 tons at Espirito Santo. The total production, including 2,300 tons from the Bicalho mine, was 383,000 tons, an increase of 29,500 over that of the previous year. The average grade of the ore was 10.93 grams gold per ton. Increase in taxation is said to be severe because it is charged on the entire profit of the company, although only one-third of the proceeds of the gold is paid for in sterling, two-thirds being compulsorily retained in Brazil. The reserves at the Morro Velho mine are estimated at 5,160,000 tons of an average value of 14 grams (9 dwt.) per ton, and those at Espirito Santo at 2,769,000 tons of an average value of 9 grams (5.79 dwt.) per ton. The total reserves show an increase of 501,000 tons over those of the preceding year. The supply of labor continued to improve, the attendance at the mines showing an increase of 225 men per day as compared with that of 1938. Workmen's houses to the number of 244 were completed during the year and more are now under construction. The company has obtained from the Brazilian authorities permission to extend an existing power station. Eric Davies is manager and L. E. Langley managing director.

▶Production by Braden Copper Company, in Chile, was on a restricted, though fairly uniform, basis throughout 1939, according to the annual report by E. T. Stannard, president of Kennecott Copper Corporation. There were mined and treated 6,962,687 tons of ore having a copper content of 2.15 per cent. The concentrates resulting therefrom assayed 31.48 per cent Cu, and smelter production totaled 260,939,595 lb. of copper. In 1938 and 1937 output was 264,067,321 and 318,169,808 lb. respectively. With the outbreak of war and the interruption in shipping, all markets for Braden current output were cut off for a period of about two months, though operations continued. Recently production and deliveries have been about 11,000 tons per month. The erection of new living quarters and the modernization of those built some years ago continued on an active basis and further appropriations for the same purpose have lately been made. A Symons short-head cone crusher was installed in the coarse-crushing plant in substitution for rolls, and new and larger transformers were placed in the Coya generating station to increase power output. The foundry was further improved and is now equipped to manufacture practically all sizes and varieties of castings, including those made of manganese steel, at a considerable saving in cost over purchases from abroad. Construction of the Pangal concrete-lined pressure conduit continued, and this project, which will cost about $1,050,000, will be completed soon. Toward the end of 1938 experimental work was started looking to the recovery of a small varying amount of molybdenite occurring from time to time in the Braden ore. By December, 1939, experimental results were sufficiently favorable to justify the installation of a permanent molybdenite recovery plant, which is now in course of erection and should be completed about July 1, 1940. During the year several hundred tons of low-grade molybdenite concentrates were produced in the course of testing work, and these will eventually be re-treated to make them marketable. From present indications molybdenite production from this property will probably never be large, but should amount to at least 1,500,000 lb. per year when mining and treating 7,000,000 tons of ore annually. Apart from occasional seasonal shortages of men, more particularly at the mine, the labor supply was ample for all requirements. As forecast in the last annual report, the Government of Chile early in 1939 found it necessary to augment income, and effective as of Jan. 1, 1939, increased the income tax rate from 18 per cent to 33 per cent. The large increase in the rate is greatly to be deplored and resulted in a sizable reduction in 1939 profits from the Chilean unit.

CANADA

Sherritt Gordon Mines Finds Ore in Depth

Diamond-drilling projects vein well below the sixth level—Jellicoe Mines developing drilled area with good results—Iron deposit in British Columbia attracts interest

▶Sherritt Gordon Mines, in northern Manitoba, which is shipping copper-zinc concentrates to the Flin Flon smelter, reports steady progress in the mine-expansion program that was begun in 1937, when the mine reopened. The East mine has recently gone into production and is now in condition to provide a considerable tonnage. The West mine is developed down to the sixth level and recent diamond drilling has intersected ore 600 ft. below that horizon.

Quebec

▶The main operating No. 7 shaft at Lamaque Gold Mines is being deepened from 2,000 to 3,600 ft. as part of a long-range development program. Shaft stations are cut at intervals of 600 ft. The new vein system discovered when the shaft was bottomed three years ago has only recently been opened on lower levels. At the 2,400 level it is planned to connect the main shaft with the No. 1 winze, where a block of twelve new levels above this horizon will be extensively worked this summer. In February ore reserves reached a new high at

865,865 tons, sufficient to supply the 1,200-ton mill for two years.

▶ At Central Cadillac Mines an extension of the No. 8 oreshoot has been indicated below the fourth level, and drill exploration is being carried to greater depth. A monthly operating profit of better than $15,000 is being secured from the leased mill on the Thompson Cadillac property, 2½ miles to the west. Ore is trucked at the rate of 180 tons daily, development ore grading $7.32 and surface dump material $9.30 a ton. J. Evans is mine manager.

▶ Thayer Lindsley, president of Pascalis Gold Mines, reports that shaft sinking to a depth of 1,000 ft. has been started at a point 825 ft. from the west boundary. Depth exploration will later test ore indications from drilling to maximum depths of 1,625 ft. E. V. Neelands is consulting engineer.

▶ Partanem Malartic Mines has started a 500-ft. shaft and plans to open three levels to explore two ore zones located by diamond drilling two years ago.

Ontario

▶ Bidgood Consolidated Gold Mines, 3 miles east of the main Kirkland Lake camp, is now opening a new orebody on the 775 drift, and followed down by a winze to the 900 sublevel, where drifting in both directions has established ore of about half-ounce grade for stoping widths of around 5 ft. Ore reserves were at the point of exhaustion when the discovery was made, following persistent exploratory efforts by the mine manager, F. L. Smith.

▶ A temporary mill shutdown is in effect at Straw Lake Beach Gold Mines while the shaft is being deepened for a new level.

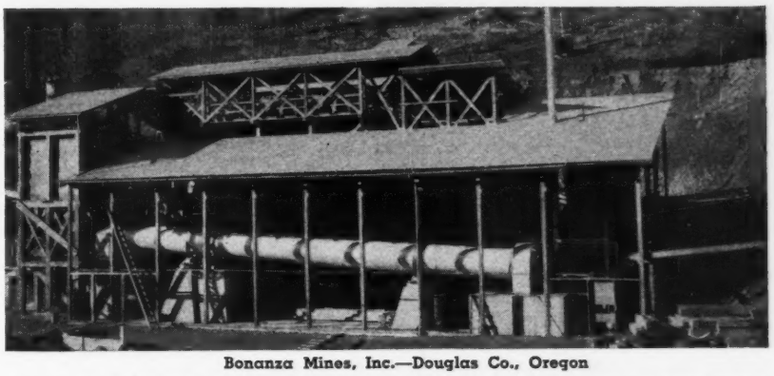
▶ Jellicoe Mines (1939), formerly Jellicoe Consolidated Gold Mines, is approaching a self-sustaining basis through daily treatment of 30 tons of ore in the neighboring mill of Magnet Gold Mines. An oreshoot containing 12,000 tons of half-ounce grade, above the second level, is being mined and a long exploratory drive west on the 500 level will be continued for another two months to investigate a favorable area that was found several years ago in drilling.

▶ Howey Gold Mines, pioneer producer in the Red Lake section, completed its first decade of profitable operation in March. Plant and equipment and preproduction costs have been written off the books, leaving all net profit, less taxes, for dividends. Large holdings in East Malartic are expected to swell earnings this year. R. T. Birks is president. Howey, in association with four other companies, has optioned two promising Amphi properties in the Malartic section of Quebec. Work is now progressing under supervision of R. Murphy, geologist.

British Columbia

▶ Surface prospecting at the Zeballos property of Privateer Mine, Ltd., has been resumed and a contract made for 5,000 ft. of diamond drilling. Several veins will be drilled and favorable areas cross-sectioned.

▶ Ore well up to mine average as regards width and values has been opened



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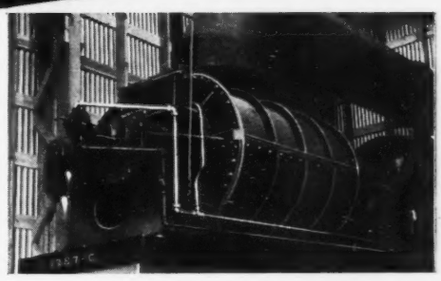

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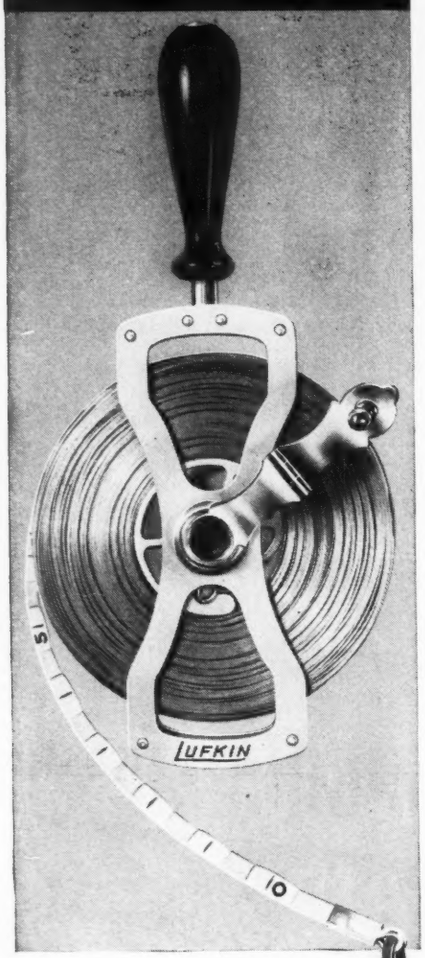

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▶CANADA

for 150 ft. on No. 3 level at Central Zeballos Gold Mines, Ltd., according to W. A. Sutton, secretary-treasurer of Reno Gold Mines, Ltd., the operating company that has a 40 per cent interest in earnings.

▶With relatively well-assured tonnage estimated at 984,028 tons, the preliminary report on the F. L. iron property, Zeballos, by John S. Stevenson, of the British Columbia Department of Mines, indicates a profitable ferrous operation of some magnitude. Grade of the magnetite, shown by analyses made at the Mines Branch, Ottawa, on a 200-lb. sample taken at random along the property's magnetite bluffs, is 67.76 per cent iron. Estimated possible tonnage of the iron property (including well-indicated ore) is set at 1,425,840 tons. In view of the extreme paucity of workable Canadian iron-ore deposits — at least thus far revealed—the British Columbia discovery has material significance. The relative purity of the deposit is also an important factor.

▶In the Omineca mining division the Omineca Gold Quartz Mining Company, Ltd., advanced straight-line tunneling during last season's work from 300 ft. to over 700 ft. According to Fred M. Wells, president and manager, extension of the main tunnel this summer is expected to be accomplished at the rate of at least 200 ft. per month. Need for fuel oil has been dispensed with by installation of a Pelton wheel-power plant, a cement dam supplying water at 900-ft. pressure.

▶For the seven months of the fiscal year ended March 31 in which the plant of Pioneer Gold Mines of British Columbia, Ltd., Bridge River district, was operating (the property was shut down for about five months owing to labor trouble), bullion production amounted to $1,272,062, compared with $1,974,140 for the whole of the previous year. Dr. Howard T. James, managing-director, estimated ore reserves at March 31, as 423,009 tons, averaging 0.447 oz. of gold per ton, compared with 470,470 tons of 0.445 oz. average last year.

▶Substantial improvement in net earnings and a greater recovery of gold from the previous quarter are shown in the report recently issued by Hedley Mascot Gold Mines, Ltd., for the first three months of this year. Ore is now being drawn from six or seven different stopes, five of which are between the 4,800 and 5,000 levels in the No. 5 ore zone. The others are immediately above the 4,400 level.

▶Crosscutting operations at Holland Gold Mines, Ltd., which adjoins the rich Pioneer and Bralorne properties in the Bridge River area, are progressing favorably and should reach ore of the company's first vein shortly. Francis Holland is mine manager.

▶In the Clinton mining division, north of Bridge River, encouraging reports have come from the Vidette mine, with announcement that the face of the raise put up on the vein from the 515 ft. station on the crosscut is now in ore 14 in. wide. Richard Avison is mine manager.

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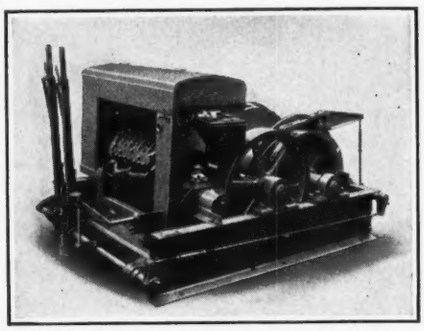

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AFRICA

Nchanga Copper Output Set for 5,000 tons Monthly

Pilot plant of 500 tons' daily capacity has demonstrated method of ore treatment—British Government will purchase gold output of Dominions with sterling

▶ Nchanga Consolidated Copper has decided to erect a plant capable of turning out about 5,000 tons of copper a month. The pilot plant of 500 tons' daily has been giving satisfactory results. Those heavily interested in Nchanga have lent it £1,500,000 on what is described as favorable terms, and it is expected that this will be sufficient to complete the plant.

▶ The British Government is purchasing the total gold production of South Africa, and is believed to be arranging to buy all that produced in Rhodesia, the Gold Coast, and possibly in Canada and other dominions and colonies. As such gold can be paid for in sterling, it lightens the burden of acquiring dollar exchange needed to pay for airplanes and other supplies necessarily bought in the United States. This arrangement appears to be wholly satisfactory to the gold-mining companies.

▶ Though no official figures are being disclosed, it is reported that the several Northern Rhodesia copper companies have largely increased their outputs, Mufulira's being now, it is said, nearly double what it was a year ago. This expansion of production is evidently for the purpose of supplying the war needs of Britain and France, and as is true of gold also, such copper can be paid for with sterling. During the previous war practically all the copper purchased had to be paid for in dollars.

AUSTRALIA

Norseman Gold Mines to Increase Capacity

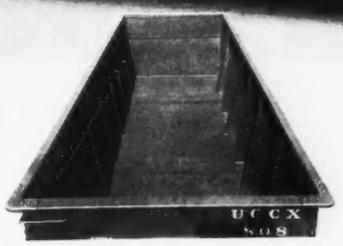
First section of plant now in operation—Big Bell Gold Mines prepares for underground exploitation —Good progress reported at Lake George Mines, Ltd.

▶ The Commonwealth Government will continue its policy of subsidising the mineragraphic and ore-dressing research work carried out by the Council for Scientific and Industrial Research, and has just made a grant of £22,000 Australian currency, which will enable the work to proceed for five years from the beginning of 1941.

Western Australia

▶ During 1939, Big Bell Gold Mines, Ltd., at Big Bell, near Cue, opened up another level, No. 3, at a depth of 430 ft. Nearly all the ore mined came from glory holes, which will last another few months, after which underground mining methods will have to take their place. A dragline and diesel shovel were

Side View New 100-Ton Ore Cars



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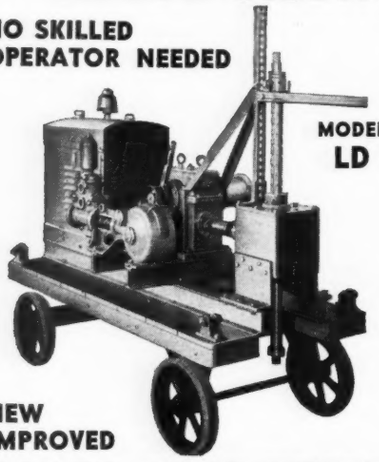

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used to remove overburden from the hanging wall. Among other construction completed was an air-conditioned dormitory of 50 beds for the use of night-shift men during the summer months. About 400 men are employed at the mine. Dale Pitt is general manager.

New South Wales

▶ The Central Mine of the Sulphide Corporation, Ltd., at Borken Hill, was closed down March 21, with no prospect of reopening. The mine had been working for 53 years, and produced 5,250,000 tons of ore.

▶ Lake George Mines, Ltd., at Captain's Flat, has succeeded in reducing costs to 29/4, Australian currency, per ton, and as output has now reached the prospectus estimate, the financial position should improve. Reserves have increased to 1,881,423 tons assaying 7.5 per cent lead and 12.7 per cent zinc through recent development.

PHILIPPINES

Metal Production Shows Steady Increase

Copper, chrome, and iron ore output in 1939 shows substantial growth of the mining industry—Surigao mine indicate good prospects for ore in depth

▶ Development at the Surigao mines continues satisfactorily. Some geologists two years ago were of the opinion that the deposits were purely epithermal and had limited depth extension. However, at present Mother Lode is enjoying promising developments on the 500 level and plans are to crosscut from the 700 ft. level with the vein fully as strong on 500 and carrying better values than on the 200 level. Surigao Consolidated recently cut its station at 300 and has stepped-up production to 12,000 tons per month. East Mindanao is sinking to the 600 on the Mindoro vein and samples in the 600 winze indicate ore above average grade for the mine.

▶ In the Agusan field some sensational assays have been obtained from new prospects. This area is inaccessible at present, but a strong company has recently taken over the prospect and plans development.

▶ Davao Gold, in the Philippines, is situated at the tip end of Davao Island, controlled by the Elizalde company. Millions of pesos have been spent in development and equipment, and the mine is said to be a small replica of Bulolo, although it is a lode deposit and not a placer area. Airplane transport is used to reach the property. A substantial tonnage of better than average ore is available.

▶ Production of metals and ores in the Philippines during 1938 and 1939, according to the Chamber of Mines of the Philippines follow:

	1938	1939
Gold, oz.	902,953	1,033,037
Silver, oz.	1,167,612	1,349,454
Copper ore, tons	17,733	25,333
Copper concentrate, tons	3,888	6,046
Chrome ore, tons	40,353	132,177
Manganese ore, tons	58,143	29,394
Iron ore, tons	912,405	1,166,781
Lead, tons	.....	44

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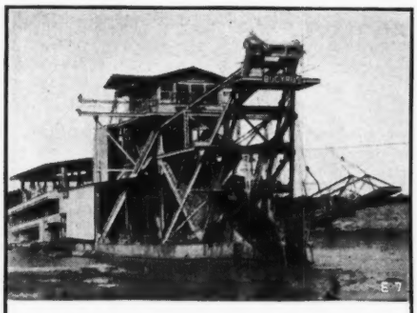

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NEW BOOKS

The Physics of the Divining Rod

A review[1] by A. C. Byers and R. G. Kazmann

"THE PHYSICS OF THE DIVINING ROD." By *J. Cecil Maby, B.Sc., A.R.C.S., and T. Bedford Franklin, M.A., F.R.S.E.; XV, 452 pp. 8 vo., cloth, 6 plates, 51 figures, bibliography, glossary, and index. London,* 1939. *G. Bell & Sons, Ltd. Price* 21s.

THE AUTHORS of the book, both of whom are members of the "British Society of Dowsers," attempt to demonstrate that the diviner's "art" is based on muscular reaction to physical radiations. They try to prove that dowsing, or divining, is more than mere clairvoyance or the physiological response to suggestion.

A good example of the authors' so-called "factual" approach to the problems discussed is afforded by the fourth chapter, entitled "Proofs of a physical basis to water divining." At the beginning of the chapter a list of "initial premises" is given which takes for granted all the phenomena that are supposed to be under investigation. An abstract of the most important of these premises is as follows: that dowsers react to a physiological stimulus of external origin; that such reactions are "truth-telling," and are ". . . associated with certain physical objectives, such as . . . underground water; that electrical conductors . . . were more active in the dowsing sense," implying that dowsing has a basis in electricity or radio; that electromagnetic recording instruments (devised by members of the British Society of Dowsers) have recorded ". . . bands of disturbance in the general electromagnetic and electrostatic field of the earth . . . that seems to concur with certain reaction bands found by dowsers with their rods and pendulums"; that local magnetic effects have been measured in relation to running water; and that "earth rays" have been photographically detected.

Very little attention is devoted to psychic or extra-sensory explanations. The authors purport to set themselves the task of establishing a firm physical basis for the movements of the divining rod. However, in spite of their protestations of scientific detachment, they can justly be charged with wishful thinking, unconscious seeking of positive results, and the frequent abuse of the "cause-effect" relationship. Logical fallacy follows logical fallacy, clothed in pseudo-scientific jargon, to form a book with the superficial aspect of a scientific text but with the contents of a gadgetized superstition.

Their peculiar experiments are not generally described in detail—only general results are given. Their procedures are not fully discussed and controls are generally absent. In general, their experiments are not susceptible of precise repetition.

Thirty-nine pages are devoted to the propositions that cosmic radiation is the primary cause of the movement of the divining rod, that such radiation incident upon conductors at or near the earth's surface excites those conductors to the emission of showers of electrons and high-frequency electromagnetic waves, and that "the showers of electrons produce the dowser's reactions by direct ionisation of his nerves and muscles and such reactions are always found close to the ground or any object in air upon it."

The authors state that unless water is flowing in an underground stream they cannot detect it. This, presumably, implies turbulent flow, as is common in surface streams. The fact, however, has been well established that nearly all underground water moves with extreme slowness and without any turbulence. Thus the whole argument of the authors is based on a hydrologic fallacy.

Space does not permit the quotation and citation of the numerous falsehoods and half truths with which the book abounds. As a scientific contribution the book is entirely worthless. It is full of generalities, suppositions, contradictions, pseudo-scientific phrases, and misleading, illogical thought sequences.

[1] Published with the approval of the Director, Geological Survey, United States Department of the Interior.

COPPER MINING—TECHNOLOGY, EMPLOYMENT, AND OUTPUT PER MAN. *W.P.A. National Research Project in Cooperation with the United States Bureau of Mines. Publications Section, Division of Information, Works Projects Administration, Washington, D. C. Pp. 260.*

INQUIRY into future employment opportunities in copper mining, as affected by changing technology and mining conditions, is the goal of this study. It traces major trends in the industry from 1880 to 1936, and gives separate consideration to open-cut and underground mining. A chapter on changes in ore dressing is included, because improvements in that art have greatly influenced the productivity of the industry. After examining all these factors, certain conclusions are reached on the opportunities for employment in the next decade and beyond.

Estimating 1947 production of copper at 1,000,000 tons and output per man at 38 lb. per hour, copper mining will require 21,900 men employed 300 days a year for 8 hours a day, or 29,200 men on a 6-hour shift. This estimate of employment shows a decline of 45 per cent from the 1929 level. Large deposits of disseminated ores are expected to play an increasingly important rôle in providing employment. Geographically, Arizona will become more important as a source of employment in copper mining, followed by Utah, Nevada, and New Mexico. On the other hand, the importance of Montana and Michigan is expected to decline.

QUIN'S METAL HANDBOOK AND STATISTICS 1940 (27th year of publication). *Published by Metal Information Bureau, Ltd., Ibex House, Minories, London, E.C. 3, England. Pp. 343. Price 7s. 6d.*

THIS handbook contains tabulations of figures on consumption, exports, imports, output, and prices for the major metals (including tinplate, ferro-alloys, iron and steel, and in some cases scrap) and ores of commerce; also tables of extreme prices, lists of brand names, and like data.

PUBLICATIONS

RECEIVED

Silicosis. Report of the Director of the Saranac Laboratory for the Study of Tuberculosis for the Year Ending Sept. 30, 1939. Saranac Lake, N. Y.

Safety Rules for the Installation and Maintenance of Electric Utilization Equipment (comprising Part 3 and the Grounding Rules of the 5th Edition, National Electrical Safety Code). Handbook H33 (superseding H7), National Bureau of Standards. Sold by Superintendent of Documents, Washington, D. C. Pp. 80. Price 15¢.

Nova Scotia. Annual Report on Mines. 1939. Issued by the Department of Mines, Halifax. Pp. 84.

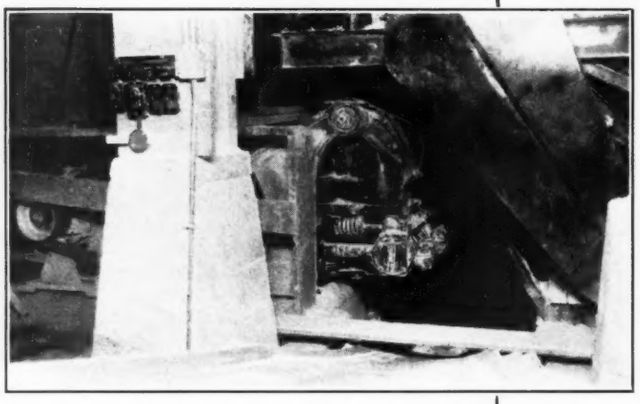
British Columbia Department of Mines, Victoria, B. C., Canada. Bull. No. 1, Aiken Lake Area, North-Central B. C. Bull. No. 2, Placer Gold Deposits, Wheaton (Boulder) Creek. Bull. No. 3, Frasier River Tertiary Drainage History in Relation to Placer-gold Deposits.

British Guiana. Report on Gold and Manganese Deposits of the Lower Barama River, Northwest District. Bulletin No. 14, 1937-38. By D. A. Bryn Davies, Geological Survey of British Guiana, Georgetown, Demerara. Pp. 32, plus map. Price 24¢, local currency.

Brazil's National Department of Mineral Production, Geological and Mineralogical Service, Rio de Janeiro, has issued the following, in Portuguese: Report of the Director for 1938, pp. 99. Also Bulletin 92, Geological Reconnaissance in the State of Sta. Catarina, by Paulino Franco de Carvalho and Estevam Alves Pinto, pp. 30, plus a map. Also Bulletin 95, Geographic Coordinates of the Grid of Brazil. This pamphlet (No. 95) accompanies the map of Brazil (in several sheets) divided into rectangles that are a half degree of latitude by a half degree of longitude in dimensions, this grid being intended to serve as a base for the geologic map of Brazil (Bulletin 95 is 140 pp. long). Also Bulletin 103, New Fossil-bearing Areas in the Northeast of Bahia, by Jose Lino de Melo Junior and Paulo Erichsen de Oliveira, pp. 85 plus a map.

South Australia. Annual Report of the Director of Mines and Government Geologist for 1938. Adelaide, Australia.

Gold Coast Colony. Report of the Geological Survey Department 1938-39. Government Printing Department, Accra, Gold Coast Colony, Africa; sold by Crown Agents for the Colonies, 4 Millbank, London, S.W.1. Price 2s.



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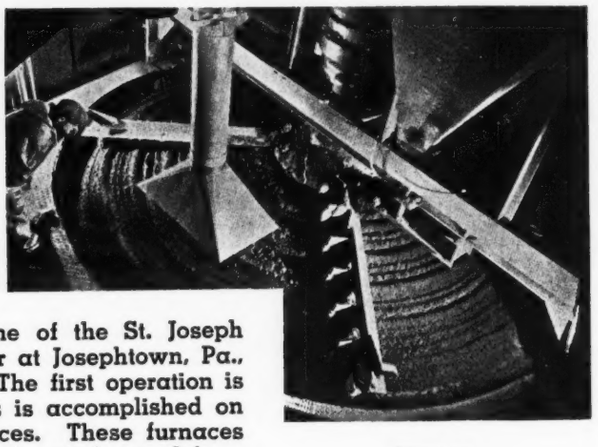
NICHOLS HERRESHOFF MULTIPLE HEARTH FURNACES and "The Story of St. Joe Electro-Thermic Zinc"



Charging Hearth Of Roasters

"Concentrates from the New York State mine of the St. Joseph Lead Company arrive at the company's smelter at Josephtown, Pa., containing about 58% zinc and 32% sulphur. The first operation is a roasting process to reduce the sulphur. This is accomplished on three 21-foot diameter Nichols Herreshoff furnaces. These furnaces have 12 hearths, and the concentrates are heated and dropped from hearth to hearth by mechanical rabbles. The resultant calcine contains 67 to 68% zinc and about 1% sulphur."

The above is one of the many examples of how these furnaces are meeting specific requirements in roasting, calcining and drying. Write for Bulletin No. 206.

NICHOLS

ENGINEERING & NERCO RESEARCH CORP.

60 WALL TOWER, NEW YORK, N. Y. UNIVERSITY TOWER BLDG., MONTREAL, P. Q.

EQUIPMENT NEWS

New Diesel Crawler Tractor

A NEW LINE of high-speed diesel crawler tractors, powered by General Motors diesel engines, has been announced by Allis-Chalmers Manufacturing Company, Milwaukee, Wis. The first of this new line, the HD14, shown here-

with, is now available and other models are planned to be released in the near future. The HD14 develops 130 hp. on the belt, 106 hp. on the drawbar, and weighs 27,000 lb. The transmission with six forward speeds and two reverse provides forward speeds from 1.72 to 7.00 miles per hour and reverse speeds of 2.00 and 3.20 miles per hour. General motors two-cycle six-cylinder engine is said to provide unusually high performance and also makes possible throttle control of a tractor, giving a range of speeds in any gear down to half rated engine speed, without loss of drawbar pull. The unit is designed to handle the larger scrapers, 12 to 14 ft. blade graders, bulldozers, trail-builders, rippers, winches, logging arches, wagons, snow plows, and other auxiliary equipment.

Vibrating Screen

A VIBRATING SCREEN known as Gyroset is announced by the Production Equipment Corporation, Chicago, Ill. Features of this screen are said to be eight positive stroke adjustments, 0 to $\frac{3}{8}$ in. stroke. Vibrator assembly is completely inclosed and all moving parts are inclosed and operate in a bath of oil. Compound eccentric balance wheels are employed to promote action and the vibration amplitude or intensity is positive as well as adjustable.

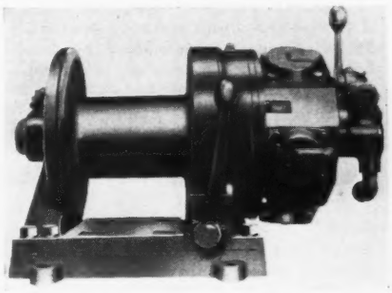
A full 150-deg. effective range of vision is offered in the new, improved No. 220 wide-vision goggle shown above, one of the latest developments of the Chicago Eye Shield Company, 2360 Dept. J, Warren Boulevard, Chicago. The nose bridge is adjustable to varying facial widths, which accounts in part for the general utility value of the new unit.

Explosion Type Motors

HIGHER HORSEPOWER explosion proof motors are now offered by United States Electrical Motors, Inc., Brooklyn, N. Y. Ratings have been increased in one group from 25 to 75 hp. and from $7\frac{1}{2}$ to 75 hp. in another group. These new large motors are of the shell-type frame construction and have a specially designed fan that is said to run quietly at high speeds. Wiring is said to be made more convenient with the new larger terminal box; for example, the cubic content of a 40-hp. 1,800 r.p.m. explosion proof motor is 600 cu.in.

Air Hoist

GARDNER-DENVER COMPANY, Quincy, Ill., announces its five-cylinder radial air motor used to power its new line of single- and double-drum air hoists. The



overlap of power impulses of this motor is said to exceed that of a modern eight-cylinder automobile engine. The new hoists are said to have smaller over-all dimensions and less weight per horsepower delivered than any other hoists of their type. They are well adapted to hoisting, hauling, dragging, or scraping in mines, smelters, quarries, highway, and construction work, bridge erection, and in machine shops and other industrial work.

Treadwell Construction Company, 626 South Twelfth St., Midland, Pa., recently introduced a line of welded-steel refuse kettles suitable for use in the smelting and refining industries. They are said to be made of special fire-box quality metal and are of all-welded construction. These kettles have a rated capacity of 19½ cu. ft.

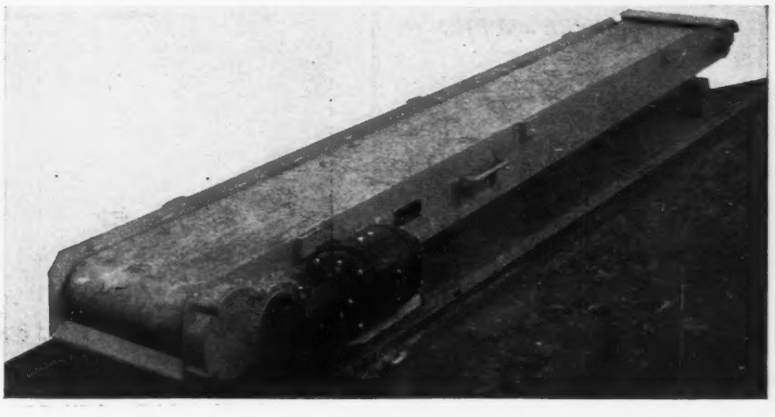
Half Yard Shovel

A NEW POWERFUL, full-size ½-yd. convertible shovel-dragline-crane, the LS-60, is announced by Link-Belt Speeder Corporation, Chicago, Ill. Claimed for this new model are several advancements, which include self-aligning roller bearings on drum shafts, reverse shaft and main power shaft; a new safety-type rapid boom-hoist for crane duty, with conventional worm-geared boom-hoist optional; double fully inclosed traction brakes controlled from the cab; and glass inclosed operator's cab. The engine is 60 hp., gasoline or diesel.

Mine-Car Derail

A NEW MINE-CAR DERAIL, designed for increased safety against runaway cars, has recently been introduced by the

A portable belt conveyor, made in 10-ft. lengths and weighing less than 425 lbs., was recently developed by the Goodman Manufacturing Company, of Chicago, Ill. Because of the light weight of this conveyor, the complete unit can be easily and quickly moved from one location to another. This portable underground conveyor has a 16-in. belt and a capacity of 25 tons per hour. Where the bottom is too "rolly" for chain or shaker conveyors, several of these units may be used in tandem, to make a face conveyor.



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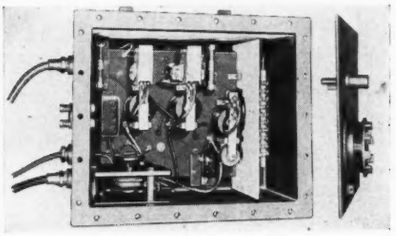
Design, Metallurgical Testing and Field Consulting Service; Manufacturers of Mill and Placer Recovery Equipment.

Portable Lamp & Equipment Company, 78 First Ave., Pittsburgh, Pa. Constructed to work like a switch, the device is fitted with a flange which guides car wheel gradually, rather than suddenly, off track. This feature eliminates danger of car wheel jumping completely over device. No tools are required for installing or removing the new Derail, and digging under rail is unnecessary.

A lightweight lubricator having a capacity of 20 lb. of grease is announced by Gibraltar Equipment & Manufacturing Company, St. Louis, Mo. It can be operated using one hand and is said to be capable of developing from 6,000- to 10,000-lb. pressure.

Improved Sand Filter Clarifier

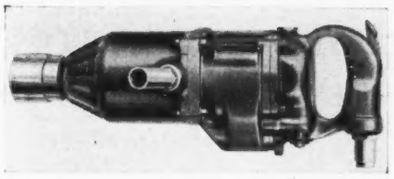
THE HARDINGE COMPANY, Inc., York, Pa., announces a new-design, heavy-duty sand filter, which is used for filtering boiler-feed water, gold cyanide solutions, and other solutions. It incorporates two new types of drives, one for intermittent operation, using standard open-type worm gearing, and the other for continuous operation with completely inclosed drive on ball bearings in an oil-filled housing. In principle, the liquid to be clarified is introduced in the tank, on the bottom of which is a sand filter bed and spiral scraping mechanism. The liquid is drawn through the filter bed by a vacuum pump or by hydraulic pressure of the liquid in the tank. As the bed becomes impervious from the sludge deposited thereon, the scraper removes this sludge to the center, where it is discharged. At the same time, a very light cut is taken off the top of the sand bed by slightly lowering the scraper. This cut removes the sludge that tends to collect between the particles of sand over long periods of time. The sand bed need be renewed only once every two to five years, it is said. The units are made in sizes from 6 ft. to 100 ft. in diameter, with capacities ranging from a few gallons up to 5,000 g.p.m.



Ohio Brass Company, Mansfield, Ohio, announces development of an explosion-proof automatic d.c. motor starter for conveyor, fan, pump, and compressor work. Designated as the Type ADG explosion-proof starter, this device controls and protects d.c. motors from 2 to 50 hp. operating at voltages of 250 and 600. Pushbutton, remote pushbutton or remote float switch control arrangements are available

The General Excavator Company, Marion, Ohio, announces its new general Supercrane, showing the wheel mount equipped with dual rubber tires. All lifting, swinging, and propelling operations are handled by one engine, one operator, and one set of controls. Booms up to 100 ft. can be handled.

Ranging in capacity from 4 to 45 cu.yd. are the world's smallest and largest Carryall scrapers, built by R. G. LeTourneau, Inc., Peoria, Ill. World's largest excavator is the Model NU, the largest Carryall yet built. With a heaped capacity of 45 cu.yd., it is designed for use on the largest earth-moving projects, with long hauls of 2,500 ft. and up.



A new reversible wrench for removing and applying staybolts, caps, dome nuts, cylinder and valve chamber head nuts, and in structural-steel work, is announced by Chicago Pneumatic Tool Company, New York. Known as Type 365R power-vane wrench, it is 16¼ in. long, weighs 27½ lb., and capacity size of bolt is 1¼ in.

Mine Timber Jack

TEMPLETON, Kenly & Company, 1020 South Central Ave., Chicago, have recently introduced the No. 366 Simplex mine timber jack; a double-acting automatic raising and lowering jack which tightens against the roof and floor and has an elevating bracket for safety lifting heavy wood or steel beams into place.

In operation, the adjustable base, with conveniently spaced holes, is pulled out to a point that will place the corrugated base closest to the floor. A pin chained to the jack so it cannot get lost is inserted through the jack.

An elevating bracket is mounted on a double-acting jack with a speed trigger which permits the jack to be moved rapidly down the rack bar close to the floor, so that beams can be easily lifted onto the brackets. A double socket permits jacking in close quarters. Beams are quickly jacked into place. The jack acts as a safety post.

The No. 366 jack is designed to provide greater safety in handling roof supports and to eliminate high lifting of timbers.

BULLETINS

Silver Brazing Alloys. Handy & Harman, 82 Fulton St., New York, N. Y. The company announces a booklet on the subject of silver brazing alloys. Pp. 27.

Texrope Drives. Allis-Chalmers Mfg. Co., Milwaukee, Wis. The company announces a revised Catalog 151 including a comprehensive engineering section on new horsepower ratings for Texrope drives. Pp. 34.

Photo-Electric Colorimeter. Photo-Electric Colorimeter Photovolt Corporation, 10 E. 40th St., New York, N. Y. Folder describes and illustrates the Lumetron photo-electric colorimeter for use in quantitative chemical analysis by colorimetric methods. Pp. 6.

Diesel Electric Set. Caterpillar Tractor Company, Peoria, Ill. Forms 1823-123A and 1923-124A describe and illustrate features of the manufacturer's larger self-contained diesel electric sets of 66 and 52 kw. respectively. Pp. 2.

Flange Jacks. Garlock Packing Co., Palmyra, N. Y. Folder describes features of new tool for replacing gaskets in flanged pipe lines. Pp. 4.

Centrifugal Blowers and Compressors. De Laval Steam Turbine Co., Trenton, N. J. Catalog F describes and illustrates the manufacturer's line of blowers and compressors. Tables of properties of gases and laws of compression are also included. Pp. 52.

Air Hoists and Air Motors. Gardner-Denver Co., Quincy, Ill. Bulletin H-1 describes and illustrates the manufacturer's new line of air hoists. Pp. 12.

Sinking Drill. Bulletin S73 describes and illustrates the manufacturer's new S73 sinking drill. Pp. 4. **Drifter.** Bulletin D73 describes features of the company's new 2¾-in. D73 drifter. Pp. 4.

Spray Painting Equipment. The DeVilbiss Co., Toledo, Ohio, has issued a hand booklet describing many items of spray-painting equipment. Part of the book is presented in question and answer form, covering spraying methods. Many drawings are shown and the booklet is well indexed. Pp. 32.

Mine Track Equipment. Bethlehem Steel Co., Bethlehem, Pa., has published Booklet 72-A on mine-track equipment for coal and ore mines, quarries and industrial plants, describing ties, frogs, switches, guard rails, crossings, turnouts, and light rails. Pp. 135.

Electric Hammer. Dewar Mfg. Co., 34-35th St., Brooklyn, N. Y. Leaflet describes the company's Model C Meeker electric driven power hammer. Pp. 2.

Magnetic Separators. Magnetic Engineering & Mfg. Co., Clifton, N. J. Bulletin 140 describes the features of design of the manufacturer's magnetic pulleys.

Mine Cars and Truck. Sanford-Day Iron Works, Knoxville, Tenn. Catalog 36 is a handsomely bound catalog describing and illustrating the manufacturer's mine cars and trucks, car wheels, incline drums, industrial cars and trucks, trailers, sheaves, rollers, and accessories in the field of materials transport. Features of the company's various sizes and types of automatic drop-bottom mine cars are illustrated and explained. Pp. 139.

Gas Engines. Worthington Pump & Machinery Corp., Harrison, N. J. Bulletin S550-B7 describes and illustrates features of the manufacturer's vertical four-cycle gas engines. Pp. 8. **Air Compressors.** Bulletin H-620-B22 explains features of Types VA and VA2 two-cylinder air compressors. Pp. 4. **Rock Hammers.** Bulletin H-1200-B26 describes and illustrates the company's No. 45 rock hammer. Pp. 4. **Drill Rig.** Leaflet A-1200-M6 describes features of its Rock Master drill rig Model UPW. Pp. 1. **Drifter Drill.** Leaflet H-1200-B27 describes the company's No. 180 pneumatic-feed drifter drill. Pp. 1. **Portable Compressors.** Leaflet H-850-M4 describes its 6-cylinder streamlined portable compressor. Model 105. Pp. 1. **Gas Engine Compressors.** Bulletin L-600-B10 describes and illustrates features of the company's gas engine compressors. Pp. 10. **Steam Jet Ejectors.** Bulletin W-205-B7 describes the manufacturer's two-stage condensing type steam jet ejectors. Pp. 6.

Arc Welding Electrodes. General Electric Co., Schenectady, N. Y. Bulletin GEA-1546F gives suggestions on welding technique with different types of electrodes. Pp. 40. **Pyranol Capacitors.** GEA-3225 is entitled "Power Factor and Its Improvement." **Switchboard Instruments.** GEA-1758B describes features and specifications of the company's line of rectangular switchboard instruments. Pp. 12. **High-Speed Synchronous Motors.** GEA-246F describes the "7500 Series" motors. Pp. 4. **Cable Digest.** GEA-3280 offers data on insulated cable for low-voltage power circuits. Pp. 17. **Magnetic Starter.** GEA-3248 describes features of the company's new d.c. magnetic starter type CR-4052. Pp. 4. **Portable Instruments.** GEA-1784B describes and illustrates a.c. and d.c. portable instruments, voltmeters, wattmeters, etc. Pp. 28. **Time Switches.** GEA-3339 describes its general purpose automatic time switch-type T27. Pp. 7. **Small Magnetic Starter.** GEA-3250 describes the type CR-7006-D-50 small magnetic starter. Pp. 4. **Fuse Cutouts.** GEA-1993F describes inclosed indicating and drop-out fuse cutouts. Pp. 11. **Demand Meters.** GEA-3226 describes types of demand meters for maximum demand measurements. Pp. 15. **Diactor Generator-Voltage Regulators.** GEA-2150B describes and illustrates its type GDD diactor regulators for direct current machines. Pp. 15. GEA-3279 describes diactors for a.c. generators. Pp. 4. **Battery Charger.** GEA-3179-A describes the CR-7501-K phano-charger for storage batteries. Pp. 4. **Repainting Transformers.** GEA-677B supplies instructions for repainting transformers in the field. Pp. 3. **Improved Frame Heads.** GEA-264A describes the company's improved frame heads for mine locomotives. Pp. 2. **Reactrol System.** GEA-3301 describes and illustrates the company's new control drive for electrically heated equipment, furnaces, boilers, etc. Pp. 6. **Capacitor Motors.** GEA-2915A describes the company's type KC ¼- to ¾-hp. general-purpose capacitor motors. Pp. 7. GEA-3337 is entitled "Announcing a New Method for Reducing the KVA Demand of Resistance Welding Machines." Pp. 4. **Thrustor Operated Valves.** GEA-1569B describes the company's thrustor operated valve for pipe sizes of 1 to 10 in. Pp. 2.

Centrifugal Pumps. Allis-Chalmers Tractor Division, Milwaukee, Wis. Form MS 253 describes the manufacturer's engine-

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PLAT-O HEAVY DUTY VIBRATING SCREENS for large tonnages ore, sand and gravel, crushed stone, etc. *Bulletin No. 26.*

MULTIRAP VIBRATOR—High speed for fine screening. Non-blinding, high efficiency, long life screen cloth. *Bulletin No. 24.*

COMPOUND FUNNEL CLASSIFIER—Gold trap for coarse gold. Preparation of ore pulps for table concentration. *Bulletin 23.*

DEISTER MACHINE COMPANY

1933 East Wayne Street Ft. Wayne, Ind.

driven centrifugal pumps. Pp. 4 **Transformers.** No. B6043 describes the company's transformers containing Chlorextol, a non-inflammable insulating liquid. Pp. 4.

Diamond Drills. E. J. Longyear Co., Minneapolis, Minn. Bulletin 57 describes and illustrates features of the company's UG Straitline diamond core drill. Pp. 7.

Roller Chains. Morse Chain Co., Ithaca, N. Y. Bulletin R-54 describes and illustrates features of the company's line of roller chains, and contains engineering data. Pp. 24.

Furnace Refractory. Basic Dolomite Inc., Cleveland, Ohio. Folder describes and illustrates the manufacturer's new refractory R mix for electric and non-ferrous furnaces and open hearths. Pp. 6.

Portable Crushers. Diamond Iron Works Inc., Minneapolis, Minn. Catalog 5-40-J describes the manufacturer's portable crushers of various sizes. Pp. 8. **Jaw Crushers.** Bulletin D40D describes and illustrates features of the company's line of jaw crushers. Pp. 12.

Product Directory. Allis-Chalmers Mfg. Co., Milwaukee, Wis., offers its 1940 book that is a complete directory of engineering literature, bulletins, and names the many products made by the company. Pp. 32.

Bronze Chains. Link Belt Co., 307 N. Michigan Ave., Chicago, Ill. Folder 1804 describes features of the company's bronze detachable and pintle chains. Pp. 4.

Hose, Fittings, and Couplings. United States Rubber Co., Rockefeller Center, New York, N. Y. Form M-9333 describes and illustrates the manufacturer's line of hose. The booklet called "Hose Hints" shows features of fittings and couplings and lists informative data for consumers. Pp. 33.

Alloyed Cast Irons. Thomas Foundries, Inc., Birmingham, Ala. Folder describes nickel alloyed cast iron and other products made by the manufacturers for industrial uses. Pp. 4.

Coil and Elliptic Springs. Fort Pitt Spring Co., P. O. Box 1377, Pittsburgh, Pa. Catalog No. 4 describes and illustrates the manufacturer's various types of springs. Specifications, calculations, formulas, and other useful engineering data are found in this comprehensive book on springs. Pp. 36.

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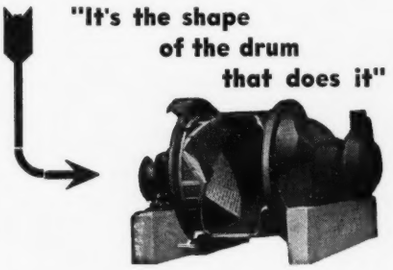

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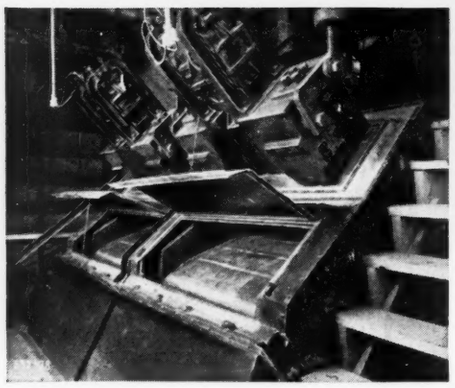

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